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ABSTRACT

This competency-based education curriculum for teaching the orientation and safety program for the oil and gas industry in West Virginia is organized into seven units. These units cover the following topics: introduction to oil and gas, first aid, site preparation, drilling operations, equipment familiarity, well completion, and preparation for employment. Each unit is divided into a number of tasks. For each task, an introduction, learning activities, student reference information sheets, and student evaluation questions are provided. (Examples of tasks are the following: know the driller's safety responsibilities, learn the job of the casing crew, work with the rotary kelly, and build a transmission line.) Line drawings are used to illustrate the information sheets, and a glossary is included in the packet. (KC)

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# Competency Based Education Curriculum
# for the
# Orientation and Safety Program
# of the
# Oil and Gas Industry

Developed by

United Career Center
Clarksburg, West Virginia

Produced at

The West Virginia Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271

This curriculum was developed by United Career Center through the cooperation and support of the Bureau of Vocational, Technical and Adult Education, West Virginia Department of Education.

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# PREFACE

It is with great pleasure that we bring you another West Virginia competency based education (CBE) curriculum. This competency based Orientation and Safety Program for the Oil and Gas Industry was developed under contract by United Career Center for West Virginia. The effort was coordinated by staff of the West Virginia Bureau of Vocational, Technical and Adult Education.

This document is organized into seven units. The units and the competencies for each are given in the table of contents. Each student competency sheet includes the unit, task, introduction, learning activities, student references and evaluation.

A special thanks to Mr. Bob Lykens, Director, United Career Center, for his effort and many hours and miles he put into this project. Additional copies of this curriculum are available from the:

West Virginia Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271
Telephone: 372-8673 or
in-state toll free 1-800-642-2670

I trust this material will be of assistance in your program. Any suggestions you may have for improving this curriculum may be sent to the Vocational Curriculum Laboratory. Through this feedback we plan to continually update and revise our materials.

VOCATIONAL, TECHNICAL AND ADULT EDUCATION

Clarence E. Burdette

Clarence E. Burdette
Assistant State Superintendent of Schools

# OIL & GAS INDUSTRY

## I. INTRODUCTION TO OIL & GAS

1. Learn How Oil and Gas Were Formed
2. Become Familiar With How to Discover Oil and Gas.
3. Become Familiar With the Methods for Drilling for Oil and Gas
4. Review Decisions That Must Be Made From Where to Drill to Well Abandonment

### Companies

1. Determine What an Operating Company Is
2. Determine What a Drilling Company Is
3. Define and Describe a Service Company and Supply Company
4. Identify Specialist Companies and Their Responsibilities

### Petroleum People

1. Identify Roustabout
2. Know the Roustabout's Safety Responsibilities
3. Identify a Derrickman's Job
4. What are a Derrickman's Safety Responsibilities?
5. Define the Driller's Job
6. Know the Driller's Safety Responsibilities
7. Know the Tool Pusher's Responsibilities
8. Know the Tool Pusher's Safety Responsibilities
9. Define a Motorman
10. Define the Rig Mechanic's Job
11. Identify a Rig Electrician
12. What is a Mudman?
13. Learn the Job of the Casing Crew

## II. FIRST AID

1. Define "First Aid"
2. Practice First Aid Steps
3. Perform Mouth-to-Mouth Resuscitation
4. Perform the Back Pressure Method of Artifical Respiration
5. Control of Bleeding
6. Locate Pressure Points
7. Apply a Tourniquet
8. Apply Constricting Bandages
9. Identify and Treat for Physical Shock
10. Demonstrate and Explain the Treatment for Physical Shock
11. Identify Cause and Explain Treatment of Fainting
12. Treat Open Wounds
13. Dressing Wounds
14. Define Closed Wounds and Practice Treatment of Closed Wounds, Sprains and Hernias

# ACKNOWLEDGEMENTS

The planning, organizing and coordinating of the development of this competency-based curriculum for the Oil and Gas Industry required the working together of many people of specialized skills and abilities.

Mr. Dan Franklin was relied on heavily for the technical content of the curriculum.

Mr. DaCosta Smith, III, of S & W Jack Drilling Company provided the original suggested course outline.

Mr. Jim Guinn of Consolidated Gas, Mr. Wayne Summerfield of Allegheny Land and Mineral, and Andrea Horton of the Society of Petroleum Engineers assisted throughout the entire project.

A special debt of gratitude is owed to the workmen at the various drilling sites for their cooperation as we photographed them at work and for their explanations of their jobs.

Thanks also to Dr. Fred Harrington, and Mr. John Lynch, from the Bureau of Vocational, Technical and Adult Education, and Mr. Bill Dillon, West Virginia Institute of Technology, for their proofreading and advice.

15. Remove Foreign Objects
16. Identify and Treat Burns
17. Identify Fractures, Administer Treatment Using a Splint
18. Transport the Injured.
19. Practice Fire Safety
20. Protect Your Hands
21. Review Safety Tips for New Employees
22. Perform Rig Inspection
23. Identify the Requirements for Fire
24. Proper Storage of Flammable Liquids
25. Proper Handling and Storage of Compressed Gas
26. Operate Safely During Well Drilling and Workover
27. Use Tongs Safely
28. Use and Care of Basic Tools
29. Learn the Treatment for Snakebite

## III. SITE PREPARATION

1. Know How to Safely Operate Chain Saws
2. Know How to Work Around the Dozer Safely
3. Be Safe While Driving Off Road

## IV. DRILLING OPERATIONS

1. Making Hole
2. Running Casing
3. Fishing

## V. EQUIPMENT FAMILIARITY

1. Become Acquainted with the Rotary Drilling Rig and Its Component Parts
2. Know and Care for the Bit
3. Define Drill Stem Assembly
4. Working with the Rotary Kelly
5. Identify the Block and Drilling Line
6. Know the Power System on a Drilling Rig
7. Explain the General Arrangement and Principle Purpose of Circulation Equipment
8. Identifying Equipment and Assemblies that Make Up the Auxiliary.
9. Develop Safe Working Habits

## VI. WELL COMPLETION

1. Cementing
2. Logging
3. Perforating
4. Fracturing and Acidizing
5. Install the Christmas Tree and Tubing
6. Set Up the Separator and Tanks
7. Build a Transmission Line

## VII. EMPLOYABILITY

1. Where to Begin
2. What Do I Want in a Job?
3. Where Can I Find a Job?
4. How Do I Write a Letter of Application?
5. How Do I Prepare a Resume?
6. How Do I Complete a Job Application?
7. How Do I Get Ready for a Job Interview?
8. Be Aware of Working Conditions

## I. DUTY: Introduction to Oil and Gas

### TASK 1: Learn How Oil and Gas Were Formed

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**INTRODUCTION:**

In this lesson you will learn about the formation and chemical structure of oil and gas. You will learn of hydrocarbons and nonhydrocarbons. You will also learn how oil formations were formed.

**LEARNING ACTIVITIES:**

1. Read the student reference material and write down 3-5 questions about things you don't understand.
2. Attend a classroom lecture about formation and chemical structure of oil and gas. Discuss the information and make sure you get your questions answered.

**STUDENT REFERENCE:**

Until recently natural gas was not an important fuel in our society. In fact, it was considered a worthless by-product of oil production and was usually flared or burned off in the field. But today the use of natural gas is so widespread we would be hard pressed to do without it. But what exactly is natural gas?

There has never been complete agreement on a definition since the chemical makeup of natural gas may differ from source to source. A generally accepted description that will suit our purposes is that natural gas is a naturally occurring mixture of light hydrocrarbons and gaseous nonhydrocarbons, but it is the hydrocarbons that supply the energy. A hydrocarbon is a combination of hydrogen and carbon. They are rarely found in a pure state but are usually combined with nonhydrocarbon gases such as nitrogen, helium, and carbon dioxide. The principle hydrocarbon of natural gas is methane, which makes up to 85 to 90 percent of the total product.

In order to extract the oil and gas from formations, the rock must be permeable. This means that the hydrocarbons must be able to flow through the interconnected pore spaces to the well.

STUDENT REFERENCE (continued):

How did hydrocarbons get into the porous rock formations? Scientists theorize that animal and vegetable matter was deposited in marine sediments millons of years ago. Over this long period of time, the organic remains were transformed into gas and oil, which became trapped as the sediments changed into rock.

In the nineteenth century, people began to use natural gas as a fuel in their homes and businesses. Its use was limited to locations close to the producing wells. By 1930, transmission companies had been established, providing service to numerous towns and cities. By the 1950's, natural gas could be supplied to more people at a lower price than manufactured gas or coal.

The demand for natural gas has continued to increase as larger amounts are used in our homes and industries. In the short period of forty years, it has become one of the three dominant fuels in the United States.

EVALUATION:

Answer the following questions in writing:

1. What is a hydrocarbon?
2. How were hydrocarbons formed?
3. Name the three dominant fuels in the U.S.

## I. DUTY: Introduction to Oil and Gas

### TASK 2: Become Familiar with How to Discover Oil and Its Extraction

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## INTRODUCTION:

In this lesson, you will explore the early discoveries of oil and gas in the United States and how oil and gas is found today. You will learn about two different kinds of wells.

## LEARNING ACTIVITIES:

1. Read student reference and list 2 questions on the material you have read.
2. You will attend a classroom lecture about the discovery of oil.
3. Attend a slide presentation about the discovery of oil and its extraction.

## STUDENT REFERENCE:

In 1859, a New Haven banker decided that the time had come for the company to send someone to Titusville, Pennsylvania, to turn a headache into a money-making proposition. James M. Townsend had been on the board of directors for a number of years while various schemes to profit by the oil on its land in Titusville had been tried and failed. What the company needed was someone there in person to supervise an even crazier scheme that he thought would solve all their problems: it would drill for oil just as others had been drilling for water. In December of the same year, he sent an unemployed railroad conductor named Edwin L. Drake to Titusville to set up operations there.

Drake, for all his efforts had a hard time. The method of drilling for water was not particularly applicable to drilling for oil: within 16 feet of the surface, his drillers - when at last he succeeded in finding a crew foolhardy enough to risk time on such an unheard of venture - struck ground water and could not pump it out fast enough to continue excavating in the normal fashion. So Drake had an even stranger idea: his drilling team - a local blacksmith named Billy Smith and his son - would give up digging by hand and try hammering a pipe down into the ground instead. To accomplish this, an oaken battering

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ram was rigged to a simple windlass.

The driller, Uncle Billy Smith, visited the well site on a Sunday, just to see how things were going, and caught a glimpse of something glimmering in the drill pipe. It was oil, and the boom began. Within a few years, the hills surrounding Oil Creek were covered with derricks.

Millions of years ago, small grains of sand and rock, called sediments, were deposited in large prehistoric seas, lakes, and rivers. There the particles slowly settled and collected in layers. As more layers of sediments were added, heat and pressure on the lower ones increased until they were slowly transformed into rock. At the same time, small marine plants and animals died and became trapped in the sedimentary layers. The resulting rock formations tended to be porous, and the organic matter collected in the tiny spaces between the individual grains of rock. If the right conditions were present, the organic material slowly changed into natural gas and oil.

While this process was going on, the earth's crust continued to move. Earthquakes made the surface twist and drop. Volcanos were formed. New mountains were thrust upward. These forces distorted and sheared the sedimentary rock formations into a complex maze. In some cases, the sedimentary rock was permeable; that is, the pore spaces were connected. In these formations, the tremendous pressures forced the oil, gas, and water to flow through the porous rock. The liquids continued to migrate until they reached the surface or were trapped by a layer of impermeable rock. When the hydrocarbons could not move through the impermeable rock, they collected in reservoirs.

STUDENT REFERENCE (continued):

If the reservoir contained a mixture of gas, oil, and water, each tended to separate and find its own level in the rock formation. Therefore, the key to successful gas exploration is to find the exact location and depth of these reservoirs, which may lie as far as four or five miles beneath the earth's crust. The only sure way to locate a reservoir is to drill a well to it, but this may cost millions of dollars. Before a well is started, preliminary surface tests are conducted to locate the most promising drilling site and reduce the risk of drilling a dry hole. The first step is to obtain a topographical relief map showing hills, valleys, and other natural features. A map like this may give geologists an indication of the subsurface structure.

When a promising site is located, tests are conducted to determine if the rock formations beneath the surface are capable of being reservoirs. One of these tests is to measure the magnetic properties and density of the various formations. High readings are characteristic of high-density, nonporous rock. The grains of this type of rock are very close together, so there is little space for hydrocarbons. Low readings, on the other hand, indicate porous formations, which are capable of containing fossil fuels. These tests indicate only if the formations are capable of housing hydrocarbon deposits, but not if natural gas or oil is actually there.

Preliminary tests from thousands of square miles are evaluated, and the most promising sites are located for further analysis. The most reliable surface test is a seismic survey. A series of small explosive charges are detonated, and the surveyors record the results of sound waves bouncing off the various rock formations below the ground. By analyzing the test results, geophysicists can determine the general shape and composition of the rock layers at various depths below the earth's surface.

Therefore, although surface tests are important to petroleum geologists making the decision to drill a test well, even a seismic survey is not enough to ensure that hydrocarbons are present. However, if the rock structure is porous so that space for hydrocarbons is available and if it is permeable so the oil and/or gas will be able to flow to the well and if it is covered by a nonporous cap rock that would trap the oil and gas into a reservoir, the location may be promising enough to drill a well.

STUDENT REFERENCE (continued):

Before a well can be started, permission must be obtained from whomever owns the property. The legalities regarding land ownership, mineral rights, and leases must be thoroughly understood by all parties involved.

The mineral rights must be leased, and accompanying rights to use as much of the surface as needed must be included. This contract includes a royalty interest, which usually means that the property owner will receive a percentage of the income for the well's production. If the well is successful, the lease will normally continue as long as the production lasts. But, if the well is unproductive, the lease expires.

Once all the legal problems are solved, a wildcat well is drilled over the prospective site. A wildcat can mean one of two things. Most often it is a well drilled in an area where no production exists, but it can also mean a well drilled in the middle of a developed field but at a deeper, untested level. Drilling rigs are selected from various sizes and shapes depending on the location and suspected depth of the reserve. Whatever type of rig is selected, once it is in place, drilling can begin. Most wells today are drilled with a rotary system.

The national average for finding gas or oil with a wildcat well is about 16 percent, or one out of every six. This figure can vary between 12 percent and 25 percent, depending upon how much money is spent in obtaining information and how well this data is evaluated. In many cases, the well will have to be abandoned even though hydrocarbons are present, since they are not available in sufficient quantities to produce commercially. Even when a large profitable reservoir is discovered, usually only about 50 percent of the gas and as little as 20 percent of the crude oil can be recovered by normal means. In order to produce the additional hydrocarbons, specialized equipment must be installed. Often the cost involved is higher than the potential profit of the well, and the well will have to be abandoned.

EVALUATION:

Answer the following questions:

1. Where was the first oil found?

2. Define a wildcat well or exploration well.

3. What is an offset well or a development well?

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## I. DUTY: Introduction to Oil and Gas

### TASK 3: Become Familiar with the Methods for Drilling for Oil and Gas

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### INTRODUCTION:

You will learn the two different types or methods of drilling for oil and gas in this lesson.

### LEARNING ACTIVITIES:

1. Read student reference section and write down 2 questions on things you don't understand.

2. You will attend a classroom lecture about the methods of drilling. The lecture will be followed by discussion with time being set aside to answer questions.

### STUDENT REFERENCE:

The United States uses more energy than any other country in the world. The rate of energy consumption can be used as a measure of a country's productivity, of its wealth, and its standard of living. In any of these categories, the United States leads all of the other countries.

Most of our energy comes from petroleum, from underground reservoirs, where oil and gas have accumulated over the years. These reservoirs of porous rock come in all shapes and sizes and are found from a few hundred feet to several thousands of feet below the earth's surface. Locating a reservoir has challenged man's inventiveness and imagination since the very beginning of the oil industry. Explorative tools have ranged from the willow divining rod, to mobil units, which send a shock wave down through subsurface formations. Each formation reflects the shock wave back to sensors attached to a recording instrument which draws a picture of the formations. The one sure way of demonstrating the presence of oil or gas is to probe for it with a drill; to attempt to tap the hoped-for reservoir by driling a hole to it and thus provide a well through which to produce the reservoir's oil and gas. Only one drilling venture in nine finds oil; one in forty-eight finds an oil field. The odds against making significant discovery are even larger.

STUDENT REFERENCE (continued):

The actual well site is determined by conventional land surveying methods, after the geologists have decided where the well is to be positioned on the subsurface structure and after drilling rights have been obtained, a stake is driven to mark the well site. Once the location is found, the access road is built, and the area is cleared to provide necessary space for the drilling equipment. A rathole, which serves as temporary storage for a length of pipe called the kelly, is a dug. It is then that the drilling crew and their equipment arrive, set up and begin to make hole. Since most of the set up work is done by the roustabout, let's examine the process closely.

Some of the earliest drilling systems were variations on the cable-tool method. Drilling tools were suspended by a rope or chain cable into the wellbore, and various ingenious - if rather inefficient - methods were used to pound the drill bit into the ground to make hole. Only the lucky ones had engines to do the work. Most people figured out some system that used manpower to raise a pole called a walking beam that dropped the bit and dug out a little more soil. Others managed to contrive a system that enabled a horse to supply the power in a method that resembled a threshing machine.

The tool strings were not very heavy in comparison to the ones used later, and the bit looked something like a funnel: it was about 3 1/2 feet long and about 1 1/2 inches in diameter until it flared into a cutting edge about 3 inches wide. In the course of a normal day, the men would drill for a foot or two, then exchange the dull bit for a bigger reaming instrument, sharpen the bit, and, if necessary, pump out the hole. Then the process would start all over again. It was a very slow procedure, because each time the drillers wanted to clear out excess rock and water from the hole, the whole drill string had to be raised and operations ceased while a bailer or pump cleared out debris.

Modern versions of the cable-tool drilling system are still used, particularly where shallow wells are drilled. The power of the cable system comes from the impact action of a bit suspended from a steel drilling cable. As in the old days, the drilled wellbore is almost devoid of fluid because injecting drilling fluid is not part of the drilling system, as it is with the rotary method. Thus, the operator still has to stop to bail out the hole in order to remove cuttings produced while drilling.

Stationary cable-tool drilling rigs with their pyramid-shaped wooden derricks were in use from the 1860's until the 1920's when the portable cable-tool rig became standard.

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STUDENT REFERENCE (continued):

In rotary drilling, the power of the bit comes from a rotating motion that turns the bit in the wellbore rather than from the impact action of the bit in the cable system. The cable-tool method resembles a man digging with a posthole digger: each thrust loosens the soil by the percussion of the bit hitting the rock. The rotary method spins the bit further and further into the soil, like a dentist's drill, which it resembles in that both drills are lubricated to keep them cool and to flush out excess particles of matter.

The first rotary-designed, fluid-circulating drilling rig was developed in France in the 1860's, but it was less commonly used than the cable-tool rig until someone discovered that a rotary rig with circulating fluid could be used in areas where percussion drilling was not very successful.

The earliest oil explorationists had thought that most petroleum was located under hard-rock formations. This view was supported by the difficulty of drilling with percussion techniques in soft soil: even though the hammering of the cable-tool bit could break up the rock, the splintered fragments closed back around the bit and often wedged it in the hole.

Fluid circulation, which floated the particles of soft rock back up the shaft and out of the way of the drill bit, was an innovation that developed in the early 1880's. The technique proved successful in the unconsolidated soft soil of Texas, where the Corsicana oil field was discovered while the drillers were searching for water. The same equipment, underpowered and not perfected for use in the oil patch, made the drilling of the great Lucas well at Spindletop possible. The drillers were farmers, and their tools were minimal, but the techniques proved effective. With the advent of rotary drilling, the oil industry was launched.

Rotary rigs are by far the most common in the oil patch today. Most are portable - moved in and assembled to drill the hole and then disassembled and moved on to another drilling site. Once the decision is made to stop drilling, the well is completed or it is plugged and abandoned. A system of valves and pipes takes over the production of the well.

Several revolutionary alternatives to conventional rotary drilling are under development and testing. Some of these are the jet erosional drilling system, the continuous chain drill, Stratopax, spark drilling and the Electrodril system. Of course, these experimental drilling techniques may never come into common practice, but it is interesting to note that research continues in efforts to improve drilling methods.

STUDENT REFERENCE (continued):

As to the personnel that operate the rig, the toolpusher, or rig superintendent, oversees the rig and three crews. He is on call 24 hours a day.

The driller supervises the work of his crew members and operates the machinery. He and his crew work 8-hour shifts, or tours. At the end of each tour, each driller completes a daily drilling report, which is a written account of the job's progress.

The derrickman works high in the derrick to rack pipe during the trips in and out of the hole. Between times, he takes care of the drilling fluid. There are several crew members on each tour who operate equipment on the derrick floor and keep the rig clean and repaired.

The motorman services the engines and keeps them in good running order, except for major overhauls.

The contractor's rig needs water for drilling. Water must be trucked to most drilling sites and stored in water storage tanks. The rig requires about 21,000 gallons of water to drill the average well. In addition, the pumps are designed to release this water at 6000 lbs. PSI in case of fire. Water is picked up by powerful pumps, which send it to the rig floor, down the drill pipe, through the bit, and back up the wellbore. The tremendous weight of this fluid column holds back any oil, gas, or water that might enter the drill string, cools the bit, seals the pores of the formation, and lifts the cuttings from the bottom of the hole, which are deposited into a waste pit.

Each time the hole is drilled another 30 feet, a new length of drill pipe must be added. A length of drill pipe is brought in from the catwalk and placed in the rathole. The drill pipe is suspended in the wellbore. The kelly is broken loose, swung over, and made up on the joint in the rathole. Pulled out of the rathole, the joint is then made up on the string. Big tongs are used to tighten the joint, then the pipe is lowered into the hole. Making a connection to lengthen the drilling string may occur many times in an hour if the digging is easy. In hard formation, it may happen only once or twice in an 8-hour shift. Now the crew is ready to drill ahead for another 30 feet of hole.

When the bit becomes dull, the crew must change the bit. All drill pipe must come out of the hole. The kelly is lifted, the slips are set, the kelly is unscrewed with

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the tongs, and the kelly is lowered into the rathole for storage. The derrickman, with the aid of a safety device, climbs the derrick to take his place on the fingerboard, where the pipe is racked. Three lengths of drill pipe are pulled at once when tripping out of the hole; even so, tripping out may take some time before the bit reaches the surface, depending on the depth of the hole. Finally the worn bit reaches the surface.

Some bits, have teeth, others have inserts of tungsten carbide or industrial diamonds. A single bit may cost from $100 to $5,000, depending on the size and type. The new bit is installed and is ready to be run back into the hole. Just above the bit are run several joints of drill collars. Their purpose is to add weight to the bit and keep the hole straight. On the storage rack, we see them as heavy, thick-walled tubes, as compared to the drill pipe seen earlier. Running the bit, drill collars, and drill pipe back into the hole is called tripping in. When bottom is reached, the kelly is added to the string, and the driller starts making hole.

The driller manipulates the brake to lower and maintain weight on the bit while drilling. After drilling through several hundred feet of surface formations, large casing is run in to line the hole. Blowout preventers are installed on the top joint of the casing. Blowout preventers are actually large valves that can be closed to shut in the hole when a blowout threatens. With these safety devices installed, the driller is ready to continue making hole. The driller depends on instruments and experience for guidance. The weight indicator tells him the weight of drill string, from which he knows the weight on the bit. The mud gauge shows the circulating fluid pressure exerted by the pumps. As each foot of hole is drilled, new formations are encountered.

Operational techniques must be changed to meet the problems which arise. Depending on the type of formations and pressures encountered, one or more intermediate strings of casing may be run. Crevices in a formation may allow the drilling fluid to escape and cause lost circulation. The thief formation must be plugged before drilling can continue.

Electrical logging tools record downhole formation data by measuring the formation's natural electric potential and resistance to induced electrical flow. Other logging tools record the formation's reaction to a radioactive bombardment. After tests have been made, the operator must decide whether to set casing and try to produce the well or plug and abandon it. The decision may not be easy, for there may be doubt whether the well will produce enough to pay for the casing and completion costs. If the drill stem test and logs show this well will produce oil in commercial quantities, preparations are made to complete the well. The drill string and drill collars are tripped out of the hole and are laid down. The casing trucks come in. Each joint is marked and threads are cleaned and doped before they are run into the hole. The casing crew takes over. A guide shoe and float collar are installed on the first joint to facilitate the cementing of the casing at the bottom of the hole. Several sizes of casing may be run during the drilling of the well, depending on hole conditions.

The cement trucks are moved in and start pumping a slurry of cement down the casing, a rubber plug is sent down ahead of the cement to keep it from mixing with the mud and to signal when it seats that the head of the cement is near the bottom. Added pressure opens the plug, and the cement continues to the bottom, where it starts up the hole between the wall of the casing and wellbore. A plug, place on top of the cement collar, seats to signal that the job is finished.

Now the oil and gas in the formation is held out of the wellbore by the steel casing and the layer of cement, which must be perforated. Bullets or shaped charges are placed in the perforating gun. The shots may be wired to detonate individually or simultaneously. Run in on a wireline to pay zone depth, the charges are set off electrically to puncture the casing and cement and allow the oil and gas to flow into the wellbore.

In about 7 days the drilling operation will be completed, the drilling crew will take down the rig and move to the next well site. The pits are closed, and the location is cleaned up. If the well is a flowing well, only the Christmas tree is left standing. It may require pumping because there may be a combination of oil and gas, if so, separators and storage tanks will be required.

## EVALUATION:

Answer the following questions in writing;

1. Explain how the cable tool method of drilling differs from rotary drilling.

2. Match the drilling crew members to the correct job description.

3. Give orally or write an explanation of the following terms:

    (a) the kelly
    (b) the rathole
    (c) logging
    (d) fingerboard
    (e) tripping out

## I. DUTY: Introduction to Oil and Gas

### TASK 4: Review Decisions That Must Be Made From Where To Drill To Well Abandonment

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**INTRODUCTION:**

Discussion in this lesson will cover where to drill, drilling the well, evaluation of the well completion, well problems in production and abandonment and downhole equipment required for efficient and safe operation.

**LEARNING ACTIVITIES:**

1. View a slide presentation entitled "Introduction to Oil and Gas". As each section of the slide presentation is completed, an indepth discussion, led by the instructor, will be conducted.
2. Attend a class discussion on geologist reports, layer formations, and other information used in determining where to drill.
3. View logging charts and note the graph and how beds of sand, shale are indicated, and how you can tell the difference between water, gas or oil in these beds.
4. Read student reference section. Write down 3 questions about what you don't understand or want to know more about.

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STUDENT REFERENCE:

A geologist is a man who knows a lot about the way rocks are laid down in the earth. From his knowledge about rocks and from tests which he makes on whole layers of rocks, he can often tell a company where to drill for oil.

Along about 1859, a fellow by the name of Drake-Colonel Drake, he was called--got the idea to drill a well for oil near one of those oil springs. His rig, drilled to a depth of 69 1/2 feet and struck oil.

No matter where the rig is or what type it is, it has only one purpose: to make the hole in the ground we call a well. A rig makes hole by turning a bit. The bit is put on bottom by joints of pipe, called drill pipe. As the bit makes the hole deeper, more sections of drill pipe must be added. Before more pipe is added, it's laid out on racks near the rig. Once on bottom, the bit turns at the end of the drill stem. As it turns, the bit makes cuttings. Drilling fluid is pumped down the stem to carry the cuttings back up to the surface.

Casing is large pipe, but its purpose is to provide a steel wall for the sides of the drilled hole. The casing keeps the walls of the hole from caving in. It also serves to seal off underground formations which the hole goes through.

Once the hole has been drilled and cased and drilled some more, it comes time for a big decision. Did the hole reach oil? And if it did, is there enough oil to justiy what it costs to complete the well?

Wells are carefully evaluated before the final string of pipe, called production casing, is run. Several methods are used to evaluate a well. One of the most common and most widely used methods is simply done by carefully examining the drill cuttings as they come from the hole. Another widely used evaluation method is electrical logging. Special tools are run into a well on a special wire cable. As the tool passes the various formations, the different characteristics of each formation are detected by the tool, and a chart is made at the surface. From these charts, it is possible to get an idea of how thick the beds are, whether they are sand or shale, and whether they contain oil and gas or water.

If the logs, etc., indicate the well to be a good one, it's time to run the production casing and to cement it in. The cement is pumped down the inside of the casing, ahead of the drilling mud, until it reaches bottom. Then the cement flows out and fills the areas between the outside of the casing and wall of the hole. Cement holds the casing in place and isolates one formation from another. Now, the next thing that has to be done is to shoot holes through the production casing, the cement, and on into the formation. This operation is called perforating and is done with a perforating gun. The perforating gun uses bullets or a jet explosive charge. The perforations in the production casing are made in the best part of the oil-bearing formation. The oil flows out of the formation and into the casing through the perforations.

After the well is perforated, a smaller string of pipe, called tubing, is run in. Tubing is run in, down through the production casing. The oil flows out of the formation, into the tubing, and on up the tubing to the surface. This tubing string is easy to replace whenever it gets fouled up by corrosion, sand cutting, and so on. A packer seals off the space between the tubing and casing. Thus, the packer makes a seal so that the oil must flow into the tubing.

Special fittings, called mandrels and nipples, are run also. Mandrels and nipples are fittings which allow certain devices to be set in them. For example, side pocket gas lift mandrels will later accommodate gas lift valves. Landing nipples may be used as a place to set plugs to shut off flow in the tubing.

The wellhead is built up on top of the casing that lines the well. There are a number of wheels on it. The wheels operate valves, which, in turn, control the flow of oil from the well. The casing head is a device that provides a connection on top of the casing for the rest of the wellhead equipment. The casing spool is bolted or clamped on top of the casing head. The production casing string is hung in it. The tubing spool is installed on top of the casing spool. The tubing string is hung in the tubing spool. Above the tubing spool is the master valve. Above the master valve is a tee connection. There's usually a wing valve on the side of the tee and a swab valve on top of the tee.

## STUDENT REFERENCE (continued):

Subsurface safety devices are used to automatically shut in the well in case of emergency. When a well is first brought in, the oil often flows out on its own. But as production continues, the pressure in the formation which causes the oil to flow drops so low that the oil can no longer flow.

When oil stops flowing, it becomes necessary to help the well. This is done by installing artificial lift. Probably the oldest type of artificial lift is the sucker rod pump and beam pumping unit. Sucker rod pumps work on the same principle as the old hand pump in a shallow water well.

As the well gets older and older, other problems may crop up. For instance, the sand control job may fail, or subsurface equipment may need to be replaced. Any time this happens, a job called a workover will have to be done.

There finally comes a time when the old well just can't make enough to pay. A workover can't be done because the well just won't pay back the expense. When this time comes, about all that can be done is to shut the well in, plug the well with cement, and move out all the equipment.

## EVALUATION:

Answer the following questions in writing:

1. Given a list of terms used by the geologist, or in the drilling, logging, or completion of a well, match them with the correct definition.
2. Explain the process of perforating a well and why this is done.
3. Shown an illustration of a wellhead, name its parts and purpose.
4. Name a downhole safety device and explain now it works.

## I. DUTY: Companies

### TASK 1: Determine What an Operating Company Is

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INTRODUCTION:

In this lesson you will learn about an operating company.

LEARNING ACTIVITIES:

1. Read and prepare 2 questions about the student reference material.
2. Attend a classroom lecture about the operating company and ask questions.

STUDENT REFERENCE:

Operating companies are the financiers of the industry and are the principal users of the services provided by drilling contractors and service companies. An operating company, often called simply an operator, is a person or company who actually has the right to drill and produce petroleum that may exist at a particular site. The operator acquires the right by buying or leasing it from the person or persons who own the land under which petroleum may exist. An operator can be a major company, such as Exxon, Shell, Gulf, Texaco, Mobil, Atlantic Richfield, Phillips, Conoco, or Standard, to name but a few. Or an operator can be an "independent", a relatively small and largely unintegrated company or individual who produces and sells oil and gas but is not engaged in the transporting, refining, or marketing of it. A major oil company, on the other hand, is a large, integrated company that not only produces oil and gas, but transports it from the field to the refinery and plant, refines or processes it, and sells the products to the general public and other consumers.

A major oil company usually initiates the sequence of events that leads to the drilling of oil and gas wells in foreign fields, but independent oil operators pay for most of the wells in the United States. In fact, about 80 percent of all wells drilled in the U.S. today are financed by independents.

Operating companies, both large and small, have found it more expedient to utilize the men, equipment, and skills and experience of drilling contractors to perform the actual drilling of a well.

## EVALUATION:

Answer the following questions:

1. What is an operating company?
2. What is an independent operating company?
3. List some activities of an operating company.
4. List two national and two local operating companies.

## I. DUTY: Companies

### TASK 2: Determine What a Drilling Company Is

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### INTRODUCTION:

You will learn what a drilling company does, and what the responsibilities of the drilling company are.

### LEARNING ACTIVITIES:

1. Read the student reference section and write down 3 questions about the material you do not understand.
2. Attend a classroom lecture about drilling companies.

### STUDENT REFERENCE:

The drilling company may also be called the drilling contractor and is the company that is hired by the operating company to drill the actual hole. The drilling company is used by the operating company because of their skill, knowledge, expertise and equipment. In fact, about 98 percent of all drilling in the U.S. is done by drilling contractors. Like an operating company, a drilling company may be small or quite large. Regardless of size, the main job of the contractor is to drill a hole to the depth and specifications set by the operating company. Usually, the operator sends out an invitation to bid to several drilling contractors who he knows have the equipment and integrity to drill the well to the specifications stated in the bid invitation. Drilling contractors must be competitive in prices and services to stay in business. If a contractor is awarded the contract, it is because his is the best bid. It may not be the lowest bid, since past performances and proven capacity are also factors to be considered.

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**EVALUATION:**

Answer the following questions in writing:

1. Name a drilling company in this area.
2. Explain what a drilling company does.
3. Explain who hires a drilling company.

## I. DUTY: Companies

### TASK 3: Define and Describe a Service Company and Supply Company

### INTRODUCTION:

You will learn what a service and supply company is and some of the services and supplies they provide.

### LEARNING ACTIVITIES:

1. Read the student reference section and write down 3 questions on the material you do not understand.
2. Attend a classroom lecture about the service and supply company.
3. Attend a presentation made by a service company.
4. Attend a presentation made by a supply company and be prepared to ask questions.

### STUDENT REFERENCE:

The operating company besides contracting a drilling company also contracts with service and supply companies. A supply company will provide such supplies as casing, cement, drilling mud, drilling bits, production pipes and tanks.

The contract for making hole goes to a drilling contractor, but the operating company is usually the one that awards other contracts to the service and supply companies. (It should be noted, however, that the contractor also relies on supply companies to provide him with tools and service he needs to drill and to keep his rigs in good working condition.) Since it takes various expendable supplies such as drilling mud and bits to drill a well, the operator and contractor buy the materials from companies that specialize in a particular service.

**EVALUATION:**

Answer the following questions in writing:

1. Explain the services supplied by a service and supply company.
2. Are there drilling service and supply companies in your area?
3. If your answer to question #2 is yes, name such a company.
4. Why are service and supply companies needed?

## I. DUTY: Companies

### TASK 5: Identify Specialist Companies and Their Responsibilities

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**INTRODUCTION:**

In this lesson you will learn about several specialist companies and what they do in the completion of the well.

**LEARNING ACTIVITIES:**

1. Attend a classroom lecture about speciality companies.
2. Attend a special presentation of a local speciality company.
3. Prepare in writing, 1 question about each of the speciality companies named in the student reference material.

**STUDENT REFERENCE:**

Before, during and after the well has been drilled, many specialist companies will be called on for assistance to perform specific jobs. The speciality companies will complete a special service to help insure the success of the well. These companies are called on because they have specialized equipment and skills which will be required to perform the specialized tasks required.

Some of the speciality companies you can expect to encounter while working on a drill site are logging, cementing, perforating, and fracturing companies.

A valuable technique is well logging. The well logging company is called to a well while the crew trips out all the drill string. Using a portable laboratory, truck-mounted for land rigs, the well loggers lower devices called logging tools into the well on wireline. The tools are lowered all the way to bottom and then reeled slowly back up. As the tools come back up the hole, they are able to measure the properties of the formations they pass.

Electric logs measure and record natural and induced electricity in formations. Some logs ping formations with sound and measure and record sound reactions. Radioactivity logs measure and record the effects of natural and induced radiation in the formations. These are only a few of many types of logs available.

After the casing string is run, the next task is cementing the casing in place. An oil-well cementing service company is usually called in for this job although, as when casing is run, the rig crew is available to lend assistance.

Cementing service companies stock various types of cement and have special transport equipment to handle this material in bulk. Bulk-cement storage and handling equipment is moved out to the rig, making it possible to mix large quantities of cement at the site.

Since the pay zone is sealed off by the production string and cement, perforations must be made in order for the oil or gas to flow into the wellbore. Perforations are simply holes that are made through the casing and cement and extend some distance into the formation. The most common method of perforating incorporates shaped-charge explosives (similar to those used in armor-piercing shells). Perforating is usually performed by a service company that specializes in this technique.

When sandstone rocks contain oil or gas in commercial quantities but the permeability is too low to permit good recovery, a process called fracturing may be used to increase permeability to a practical level. Basically, to fracture a formation, a fracturing service company pumps a specially blended fluid down the well and into the formation under great pressure. Pumping continues until the formation literally cracks open.

Meanwhile, sand, walnut hulls, or aluminum pellets are mixed into the fracturing fluid. These materials are called proppants. The proppant enters the fractures in the formation, and, when pumping is stopped and the presure allowed to dissipate, the proppant remains in the fractures. Since the fractures try to close back together after the pressure on the well is released, the proppant is needed to hold or prop the fractures open. These propped-open fractures provide passages for oil or gas to flow into the well.

## EVALUATION:

Answer the following questions in writing:

1. Name three types of specialist companies.
2. Explain what the three types of specialist companies named above do for the operating company.
3. Give the names of some local companies which provide specialized services.

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## I. DUTY: Petroleum People

### TASK 1: Identify Roustabout

## INTRODUCTION:

The performance objective of this lesson it to:

1. Identify a roustabout's responsibilities and various duties.
2. Learn other terms used to describe a roustabout.
3. Identify the qualifications necessary to be a roustabout.

## LEARNING ACTIVITIES:

1. Attend a lecture explaining the roustabouts job.
2. Discuss the other terms used for a roustabout and the qualifications for a roustabout.

## STUDENT REFERENCE:

Usually two or three roustabouts are responsible for:

1. Handling the lower end of the drill pipe when it is being either tripped in or out of the hole.
2. These workers handle the large wrenches or tongs which are used to screw or unscrew the individual lengths of the drill pipe.
3. Roustabouts are expected to maintain, paint, and clean equipment.
4. The roustabouts are expected to give a helping hand wherever and whenever needed.

## STUDENT REFERENCE (continued):

Other names for roustabouts are: roughnecks, floormen, rotary helpers, rig helpers, and crewman.

The qualifications necessary to be a roustabout are that a person be willing to perform difficult and heavy work in all types of weather conditions, in sometimes remote locations with a certain element of danger.

## EVALUATION:

Answer the following questions in writing:

1. List 4 usual responsibilities of a roustabout.
2. Give 3 other names for a roustabout.
3. List any qualifications necessary to be a roustabout.

I. DUTY: Petroleum People

TASK 2: Know the Roustabouts Safety Responsibilities

## INTRODUCTION:

The performance objective of this lesson is to become familiar with and know the responsibilities of the roustabout regarding safety and accident prevention.

## LEARNING ACTIVITIES:

1. Attend a lecture on safety.
2. View slide presentation of "Lease Safety Practices."

## STUDENT REFERENCE:

To insure a safe work location, the roustabout should practice the following:

1. Be constantly alert and keep your mind on the job.
2. Use appropriate safety equipment for your protection (hard hat, proper clothing, shoes, goggles, safety belts).
3. Do not use makeshift, misfit, worn, or defective tools.
4. Work so as to avoid injury and learn to forsee and prevent accidents.
5. Do not jump off derrick floor, pipe racks, or trucks and do not slide down a stand of drill pipe or ride the catline. Use ladders or steps.
6. Do not work under drill pipe or casing.
7. Practice good housekeeping by keeping floor clean and replacing all tools in tool rack to keep everything in order.

## STUDENT REFERENCE (continued):

8. Practical jokes and horseplay are not permitted on a drilling rig. They can be the cause of serious injuries or loss of life.

## EVALUATION:

Answer the following questions in writing:

1. Be able to list 8 things a roustabout should practice to insure safety.
2. Would you wear jewelry while working on the rig?
3. While working on the rig, is horseplay a good way to boost moral?
4. Make a list of things you might be able to do to help prevent accidents.

I. DUTY: Petroleum People

TASK 3: Identify a Derrickmans Job

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## INTRODUCTION:

In this lesson you will learn what the job of a derrickman is and the qualifications necessary to become a derrickman.

## LEARNING ACTIVITIES:

1. Attend a lecture on the job and qualifications of a derrickman.

## STUDENT REFERENCE:

The derrickman works on the top platform or monkeyboard and handles the upper end of the drill pipe. When the drill pipe is tripped into or out of the hole, the derrickman guides the drill pipe into and out of the special equipment needed to run pipe. The derrickman usually keeps track of drilling fluids and the repair and maintenance of the pumps and equipment needed to circulate the drilling fluid.

To become a derrickman you will need to serve as a roustabout for a period of time where you will gain experience and learn the job of the derrickman.

## EVALUATION:

Answer the following questions in writing:

1. Tell what is the job of a derrickman.

2. How do you become a derrickman?

I. DUTY: Petroleum People

TASK 4: What are the Derrickmans Safety Responsibilities

INTRODUCTION:

The performance objective of this lesson is to learn the derrickman's responsibilities regarding safety and accident prevention.

LEARNING ACTIVITIES:

1. Attend classroom lecture on the safety practice for the derrickman.
2. View the second part of "Lease Safety Tips."

STUDENT REFERENCE:

The safety responsibilities of a derrickman are as follows:

1. A derrickman should know his job and the various duties it includes.
2. A derrickman should be alert and keep his mind on his job.
3. A derrickman should use safety equipment for protection such as hard hat, and goggles, safety belt.
4. The derrickman should conduct work in such a way to avoid injury to others and try to forsee and prevent accidents.
5. Practice good housekeeping around the location.
6. Remember that practical jokes can cause injury or loss of life.

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## EVALUATION:

Answer the following questions in writing:

1. List six safety responsibilities of a derrickman.
2. Why would you be able to work more safety by knowing your job?
3. Tell why you think good housekeeping practice will make the rig a safer place to work.
4. List some ways a practical joke might cause injury.

## I. DUTY: Petroleum People

### TASK 5: Define the Driller's Job

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### INTRODUCTION:

The performance objective of this lesson is to learn about the job of the driller and what is required to become a driller.

### LEARNING ACTIVITIES:

1. Attend a classroom lecture on the job and qualifications of a driller.

### STUDENT REFERENCE:

The driller works under and reports to the tool pusher. The driller usually has a crew of two or three roustabouts and a derrickman. The driller is responsible for the work of the crew, setting pump speed and pressure, operating the draw works and rotary table, and controlling the drill stem to make hole.

The job of a driller requires considerable skill, judgment and drilling knowledge.

To become a driller a person will serve a period of time as a roustabout and then as a derrickman in order to gain experience and drilling knowledge.

### EVALUATION:

Answer the following questions in writing:

1. Tell what a driller does.
2. Who does the driller report to?
3. What is required to become a driller?

## I. DUTY: P[illegible]leum People

### TASK 6: Know the Driller's Safety Responsibilities

**INTRODUCTION:**

In this lesson you will learn the drillers safety responsibilities.

**LEARNING ACTIVITIES:**

1. View the slide presentation: "Lease Safety Tips."
2. Attend a classroom lecture on the safety responsibilities of the driller.

**STUDENT REFERENCE:**

The driller's safety responsibilities include the following:

1. The driller should make sure that every person in the crew knows their duties before going on the job.
2. The driller should make sure that all persons know the company's procedures and safety practices.
3. The driller should see that hazardous conditions are corrected.
4. The driller should make sure that the crew works safely.
5. The driller should be sure that all protective devices are used (hard hats, goggles).
6. The driller should never run the rig too fast for the crew.
7. The driller should not assign a hazardous job to an inexperienced person.

**EVALUATION:**

Answer the following questions in writing:

1. Name six safety responsibilities of the driller.
2. Why should the driller be concerned for the safety on a rig?
3. Discuss the driller's safety responsibilities.
4. Who on the rig should see that all safety equipment are used?
5. Why do you think a hazardous job should not be assigned to an inexperienced man?

## I. DUTY: Petroleum People

### TASK 7: Know the Tool Pusher's Responsibilities

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## INTRODUCTION:

You will learn about the job of a tool pusher, and the requirements to become a tool pusher.

## LEARNING ACTIVITIES:

1. Attend a classroom discussion of the tool pusher's job.

## STUDENT REFERENCE:

The tool pusher works for the drilling contractor and is the drilling contractor's rig supervisor. The tool pusher supervises all drilling operations and coordinates the work of the driller, the derrickman, and the roustabouts.

To become a tool pusher you will need to work as a roustabout and then as a derrickman and several years as a driller in order to gain experience and knowledge in all aspects of drilling.

## EVALUATION:

Answer the following questions in writing:

1. You will be able to define the tool pusher's job.
2. Participate in a class discussion on the tool pushers job.
3. What will you need to do to become a tool pusher?
4. Who will report to the tool pusher?

I. DUTY: Petroleum People

TASK 8: Know the Tool Pusher's Safety Responsibilities

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## INTRODUCTION:

In this lesson you will learn the tool pusher's safety responsibilities.

## LEARNING ACTIVITIES:

1. Attend a classroom lecture of the tool pusher's safety responsibilities.

## STUDENT REFERENCE:

The safety responsibilities of the tool pusher are:

1. The pusher should see that all safety equipment is in good condition and used properly.
2. The pusher should make sure that all first aid equipment and supplies are available.
3. The tool pusher will be sure that all workers operate in a safe manner.
4. The pusher must make sure that all men are trained in their duties so they can work safety.
5. The pusher should take all necessary corrective steps to avoid injury.

## EVALUATION:

Answer the following questions in writing:

1. Name 5 safety responsibilities of the tool pusher.
2. Discuss the tool pusher's responsibilities.
3. Why do you think the tool pusher should be interested in the safety of the man on the rig?
4. How can a tool pusher aid in the safety of the rig?
5. Who is responsible for the first aid equipment?

## I. DUTY: Petroleum People

### TASK 9: Define a Motorman

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## INTRODUCTION:

You will learn the job responsibilities of a motorman.

## LEARNING ACTIVITIES:

1. Attend a lecture on the job responsibilities of the motorman.
2. Cover the safety responsibilities of a motorman.

## STUDENT REFERENCE:

The motorman is responsible for the engines that supply the power to run the rig. The motorman will see that all oil levels are correct and that any coolant fluids are added when necessary. The motorman will see that all fluids are changed at proper intervals to insure that the engines remain in good working condition.

The motorman will see that the working area is safe by making sure no oil, fluid, or coolant remains on the floor. The motorman will make sure that all safety devices are in place and will use safety equipment such as hard hat, gloves, goggles, and shoes.

## EVALUATION:

Answer the following questions in writing:

1. What are the motorman's responsibilities?
2. Name 2 safety requirements of the motorman.
3. Discuss the safety responsibilities.

I. DUTY: Petroleum People

## TASK 10: Define the Rig Mechanic's Job

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INTRODUCTION:

In this lesson you will learn what is expected of a rig mechanic.

LEARNING ACTIVITIES:

1. Attend a classroom lecture on the rig mechanics job and safety responsibilities.

2. Make a list of 5 things you could do to make your job safer if you were the rig mechanic.

STUDENT REFERENCE:

Not all rigs will have a rig mechanic, but if they do then the mechanic is an all around handyman. The rig mechanic will make minor repairs on the engines, pumps, and any other machinery on and around the rig.

The rig mechanic will work in a safe manner, use all safety devices and equipment, keep the work area tidy, use proper tools for the job and not use misfitting or makeshift materials or tools.

EVALUATION:

Answer the following questions in writing:

1. You will explain the job of the rig mechanic.

2. You will name five safety responsibilities of the rig mechanic.

3. Discuss the rig mechanic's job and the safety responsibilities.

## I. DUTY: Petroleum People

### TASK 11: Identify a Rig Electrician

### INTRODUCTION:

In this lesson you will learn the duties of a rig electrician and safety responsibilities.

### LEARNING ACTIVITIES:

1. Attend a classroom lecture on the rig electrician's duties and safety responsibilities.

2. Prepare, in writing, 2 questions on the student reference material.

3. Make a list of at least 5 things a rig electrician could do to be safe while working.

### STUDENT REFERENCE:

Not all rigs have a rig electrician but if they do the rig electrician will make minor repairs to generators, electric motors, and will maintain and inspect all wiring. The rig electrician will maintain the rigs lighting system and electrical distribution system and all electrical appliances.

The rig electrician will work in a safe manner and will keep all electrical equipment and appliances safe. The rig electrician will use protective equipment to prevent injury to the rig crew. The rig electrician will not allow inexperienced people to work on electrical equipment.

### EVALUATION:

Answer the following questions in writing:

1. You will name the rig electrician's duties.

2. You will name four safety responsibilities of the rig electrician.

3. Discuss the duties and safety responsibilities of the rig electrician.

I. DUTY: Petroleum People

## TASK 12: What is a Mudman

## INTRODUCTION:

In this lesson you will learn what a mudman does on a rig. You will also learn some of safety responsibilities of the mudman.

## LEARNING ACTIVITIES:

1. Attend a classroom lecture of the mudman's duties and safety responsibilities.
2. Read the student reference material and list 2 questions on the material you do not understand.

## STUDENT REFERENCE:

The mudman works for the mud company who supply the drilling fluids. The mudman makes sure that the drilling fluids are formulated to the specifications and will run regular tests on it to make sure that it meets its needed properties. The mudman might also be called a mud engineer.

The mudman will be alert to prevent accidents. He will aid all other persons in the prevention of accidents. The mudman will use all protective devices and equipment.

## EVALUATION:

Answer the following questions in writing:

1. What is the job of a mudman?
2. What are the mudman's safety responsibilities?
3. List the protective devices and equipment which the mudman should use.

## I. DUTY: Petroleum People

### TASK 13: Learn the Job of the Casing Crew

### INTRODUCTION:

Learn the job that is performed by the casing crew.

### LEARNING ACTIVITIES:

1. Attend a classroom lecture about the job of the casing crew.

2. Make a list of 5 things which you could do to be safe if you worked on the casing crew.

### STUDENT REFERENCE:

When a hole is completed and sometimes at various stages of the drilling process, it is necessary to run pipe into the hole, called casing or casing pipe. The casing will line the hole and will keep the sides from caving in or sloughing off and also will seal off troublesome formations.

The casing crew will perform their job in a safe manner so as not to cause injury to themselves or others. They will not use misfitting tools or materials. The casing crew will not walk under casing or jump off racks.

The casing crew will pay attention to the job and will not be a part of practical jokes on location.

### EVALUATION:

Answer the following questions in writing:

1. What does a casing crew do?

2. What is casing?

3. Name the safety precautions the casing crew should follow.

## II. DUTY: First Aid & Safety

### TASK 1: Define "First Aid"

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**INTRODUCTION:**

In this first lesson on first aid you will develop a definition of first aid and hear a discussion of the full meaning of the term "first aid." As part of that discussion you will learn a definition of the term and hear a discussion of the five principal aims of first aid treatment. In as many places as it is possible, both in this discussion on first aid and in the remaining units on first aid, you will hear about how first aid can best be done at a well site using oil field examples.

**LEARNING ACTIVITIES:**

1. Work alone or with one other student and develop a definition of "first aid."

2. Share your definition of first aid with the instructor and the class. Working as a class, combine the student definitions into one comprehensive definition.

3. Review the student reference material and participate in a class discussion on what first aid is.

**STUDENT REFERENCE:**

First aid is emergency care for a person who is injured or sick. It is given to prevent death or further injury, and to prevent or treat shock and relieve pain.

Petroleum work is hard and dangerous work. If an accident occurs someone must take charge of the injured person until medical aid arrives. At a well site, medical aid may not be available for a long period of time. Therefore emergency first aid, when give correctly, can restore natural breathing, stop loss of blood, prevent or lower shock, protect wounds and burns from infection, stop movement of fractures and dislocations, relieve pain, conserve strength, and greatly help the person's chance of recovery.

STUDENT REFERENCE (continued):

It is a petroleum worker's duty to know his first aid well. He may have to use it to save someone's life or someone may have to use it to save his.

First aid is not a substitute for a doctor's care. A petroleum worker is no more a doctor than a doctor is a petroleum worker. If a serious accident occurs in the field, send for a doctor immediately! If the accident is minor, make sure the injured person sees a doctor as soon as possible.

There are 5 principle aims of first aid.

1. PREVENTION OF FURTHER INJURY - Further injury is any complication that results from an injury already received. Further injury to a major injury (loss of breathing, severe bleeding, severe shock, severe burns, severe rupture or severe fractures) could be the cause of death. Further injury to a minor injury (cuts, bruises, minor burns, minor strains, minor sprains, or minor fractures), could be the cause of serious injury. Serious injury could mean a loss of job to the petroleum worker and a loss of income to him and his family. Further injuries take place because the correct first aid steps are not given; however, when given correctly, complications are less likely to take place.

2. TREATING LIFE-THREATENING CONDITIONS - When a threatening accident occurs, first aid, when correctly used, could mean the difference between life and death. The oil field trainee will learn, through first aid and common sense, to detect which conditions are the greatest threat to human life.

3. PROTECTING INJURIES FROM INFECTIONS AND COMPLICATIONS - Through the use of first aid, injuries can be kept clean and free from infection. Proper cleansing and bandaging can stop complications that cause pain, death, and disability.

4. MAKING THE INJURED PERSON AS COMFORTABLE AS POSSIBLE TO CONSERVE STRENGTH - In order to conserve strength the injured person must be comfortable. At a well site where medical help is limited, an injured person's strength is important for recovery. Medical help may not arrive for a long period of time; therefore comfort and strength could save one's life.

5. TRANSPORTING THE INJURED PERSON TO MEDICAL ASSISTANCE IN A MANNER AS NOT TO COMPLICATE THE INJURY OR SUBJECT HIM TO ANY MORE DISCOMFORT THAN IS ABSOLUTELY NECESSARY - It is often impossible for medical help to come to an injured person where he is. In the oil field transporting the person must be done carefully and smoothly. First aid technique, in moving the injured person, helps limit the complications that may take place. The petroleum worker using first aid technique will increase the comfort and recovery of the injured person.

REMEMBER

First aid is emergency care for a person who is injured or sick. It is given to prevent death or prevent further injury, to relieve pain and to treat shock.

## EVALUATION:

Answer the following question.

1. Be able to define, orally or in writing, first aid which includes at least five principal aims of first aid.

## II. DUTY: First Aid & Safety

### TASK 2: Practice First Aid Steps

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**INTRODUCTION:**

In this lesson you will hear a discussion of what actions should be taken in a first aid emergency. You will also learn what things are the most important things to do first and in what order all the steps should be performed.

**LEARNING ACTIVITIES:**

1. Review the student reference material and participate in a class discussion on first aid Steps.
2. Given situations which require first aid, decide and demonstrate the correct steps in each.

**STUDENT REFERENCE:**

Steps for Giving First Aid

1. Locate the injury: If the injured person need not be moved, then the first step is to see what is wrong with the person. In some cases such as large wounds, this is obvious; but if it is not obvious, check breathing first and then bleeding and other wounds. If the person is seriously injured and you cannot tell what the injury is, keep him lying down. Standing, sitting, or unnecessary movement can cause death or further injury in some cases.
2. If needed, give artificial respiration: We breathe automatically and with little effort. As we breathe we take in some of the air around us, strip it of its oxygen and release it again. When breathing stops for some reason, our source of oxygen is cut off. In some cases, death occurs quickly. If stoppage is caused by an accident which has not hurt the main organs of the body, there is a good chance for survival. But to survive, air must be forced into the lungs. This

is done by artificial respiration. Because the stoppage of breathing is a life-threatening condition, artificial respiration should be given immediately after the injury has been located.

3. Look for and control bleeding: The loss of 2 pints of blood by an adult is a serious matter; the loss of 3 pints can cause death. At certain points in the body, fatal bleeding may occur in one to three minutes after an accident. A cut of the main trunk of arteries of the chest and abdomen (stomach) can cause death in less than 30 seocnds. Bleeding is also a life-threatening condition. Once breathing has been restored, then bleeding must be controlled. If there is no problem with the person's breathing, then controlling the bleeding has first priority (importance).

4. Treat for physical shock: Physical shock follows every serious injury to some extent. It may develop immediately, or be delayed several hours. But when it occurs, it may affect the heart, the lungs, the digestive tract and other vital organs directly and often results in a complete loss of consciousness. Even when the victim of shock remains conscious, he is usually unable to move, loses his powers of reason and temporarily loses control of his body functions. Shock is a serious condition. And while it is not as life-threatening as stoppage of breathing or uncontrolled bleeding, it is a very serious danger to the injured person. If it is not treated promptly and correctly, it can - in combination with serious injury - be fatal. When giving first aid, a person should be aware that someone who has lost a great deal of blood, or who feels great pain is one likley to have physical shock. It is strongly suggested that treatment for shock be given after every serious injury. Keeping the body warm helps prevent the person from going into shock. The person should be covered by blankets, brattice cloth or clothing.

5. Treat wounds and treat burns: For purposes of first aid, an open wound is any injury involving a break in the skin. It may be only a scrape, or a deep wound involving arteries, nerves and muscle tissue. The great dangers with an open wound are loss of blood and infection. First aid treatment is aimed directly at these conditions. Treating wounds should take place after the other conditions breathing, bleeding and shock preventions have taken place.

STUDENT REFERENCE (continued):

6. Look for fractures and dislocations and apply appropriate treatment: Fractured or dislocated bones represent serious injury. The fact that the injured part of the body is helpless is serious in itself; yet other problems may be caused by an injury of this type. Fractured bones may have sharp, jagged edges which can cut through the skin and cause many related injuries - from cut nerves to cut blood vessels and muscles. Dislocations may result in life-long disabilities, which can cause loss of job and income if not treated quickly and correctly. Proper handling of a fracture or dislocation and correctly preparing splints or bandages can help stop many of these complications and shorten the recovery period.

7. Transport patient: It is often impossible for medical help to come to an injured person where he is. Medical equipment cannot be moved easily from one spot to another. At an oil site the accident may be hazardous and dirty. It is the responsibility of the person giving first aid to see that the patient is moved safely and without further injury, shock, or unnecessary pain.

EVALUATION:

Demonstrate the following steps correctly.

With your partner acting as the injured person, demonstrate the steps in their proper sequence, for administering first aid.

## II. DUTY: First Aid & Safety

### TASK 3: Perform Mouth-to-Mouth Resuscitation

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### INTRODUCTION:

In this lesson you will hear a general discussion of how we breath and what can cause loss of breathing. This discussion will serve as an introduction as to why artificial respiration is needed. In the course of this discussion you will be learning a definition of artificial respiration. In a later part of this lesson you will be shown how to give mouth-to-mouth resuscitation and you will get a chance to practice doing it.

### LEARNING ACTIVITIES:

1. Attend the movie "Artifical Respiration" and discuss it.
2. Read the material on "How We Breathe and Loss of Breathing" from the student reference section.
3. Attend a lecture/discussion on artificial respiration. Take notes on the definition and the steps, in the correct order, of administering mouth-to-mouth artificial respiration.
4. Attend a demonstration by your instructor on mouth-to-mouth artificial respiration.
5. Using your notes from the lecture/discussion and demonstration, practice the mouth-to-mouth method of artificial respiration on "Resusci-Anne."

### STUDENT REFERENCE:

Artificial respiration is a procedure for causing air to flow into and out of a person's lungs when natural breathing is slow or has stopped.

STUDENT REFERENCE (continued):

## THE RESPIRATORY SYSTEM

Oxygen is necessary to human life; all living tissue depends on the oxygen carried by the blood. Oxygen is found in the air around us; it enters the body each time we take a breath. Any interference with, or stoppage of breathing will cause a dangerous shortage of oxygen through out the body. If this is not corrected, death may result. To understand how artificial respiration works - and why it works - you should know something about the system of organs used in breathing.

The respiratory system is made up of three parts.

a) The air passage (nose, throat, and windpipe)
b) The lungs
c) A flexible diaphragm in the chest.

Each breath involves two separate acts.

1) Inhalation (breathing in air) - taking in oxygen through the air passage, into the lungs.

2) Exhalation (breathing out of air) - getting rid of used air from the lungs through the air passage.

During both breathing in and breathing out, air passes through the nose, throat, and windpipe.

a) As it passes through the nose, it is moistened and filtered.

b) At the lower end of the throat there are two openings, one in front of the other.

    1) The front opening leads to the lungs. It is called the trachea or windpipe.

    2) Behind the windpipe is a second opening leading to the stomach. This is the esophagus or foodpipe.

## PRINCIPLES OF ARTIFICIAL RESPIRATION

Artificial respiration is a way of causing air to flow into the lungs when natural breathing has stopped.

It is important to know that even when breathing has stopped, the heart may continue to work, sending blood through the body.

1) Life can continue in this state if fresh air is forced into the lungs so the blood may receive oxygen.

2) In many cases, this can be done by artificial respiration.

Certain things about artificial respiration must be kept in mind when using the methods shown in this course.

a) Do not waste time! Begin artificial respiration at once.
    1) Do not take time to move the person unless the place is unsafe for the person and you.
    2) Do not delay to loosen the person's clothes and to warm him.
b) The person's position is important.
    1) The proper position depends on the method of artificial respiration used.
    2) It is best to put the person's head lower than his feet to let fluids run off from the air passage.
c) Before you begin artificial respiration, the air passage must be clear.

Continue artificial respiration without stopping at an even rate until:

1) The person begins to breathe normally.

2) Or until a doctor says the person is dead.

3) Or until rigor mortis sets in. (Rigor mortis is the stiffening of the muscles after death.)

## CAUSES FOR STOPPAGE OF BREATHING

Breathing may be stopped as a result of many serious accidents. The most common causes are:

a) Electric shock
b) Drowning
c) Suffocation
d) Poisonous gases

## DROWNING

a) Drowning is a form of asphyxia since the supply of air to the lungs is cut off by water.

    1) This can result in an immediate lack of oxygen in the body.

b) The symptoms of drowning are:

    1) A loss of consciousness

    2) No breathing

    3) Water in the throat and lungs.

The position of the injured person and the first aid person is important to this method. The injured person's head and neck must be extended during respiration for air to enter the lungs.

a) Place the person on his back.

b) Remove all objects from his mouth and throat.

c) Lift up under the neck and tilt the head backwards.

d) Pull the lower jaw so the chin points straight up.

STUDENT REFERENCE (continued):

Begin resuscitation immediately. Here are the steps used in mouth-to-mouth resuscitation.

a) Pinch the nostrils together to prevent the loss of air through the nose during resuscitation.

b) Inhale deeply (breath in).

c) Place your mouth tightly over the person's mouth and blow until his chest rises.

Remember to hold the chin up at all times.

d) Remove your mouth and let the person exhale.

Turn and listen for the return flow of air.

e) Repeat this action 12 to 15 times a minute for an adult.

EVALUATION:

Answer the following questions in writing.

1) Given a verbal description of terms, be able to match the correct definition to the term "Artificial Respiration."

2) Correctly demonstrate mouth-to-mouth artificial respiration using "Resusci-Anne."

## II. DUTY: First Aid & Safety

### TASK 4: Perform the Back Pressure Method of Artificial Respiration

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**INTRODUCTION**:

In this lesson you will learn about three different types of back pressure methods of giving artificial respiration. In other lessons you have learned about some other types of artificial respiration technqiues:

**LEARNING ACTIVITIES**:

1. Attend a lecture/demonstration of the Holger Nielson method of artificial respiration. View visuals during lecture and take notes covering reason for use of this method and correct procedure.
2. With your partner, practice the Holger Nielson method of artificial respiration.
3. Attend a demonstration of changing operators, take the relief operator's role.
4. Attend a lecture/visual presentation of the Shafer (prone-pressure) method.
5. Outline the steps of administering the back pressure method of artificial respiration.
6. Take notes listing the proper procedure of performing the Shafer method of artificial respiration as your instructor demonstrates the administering of the back pressure method.
7. Practice with your partner the Shafer method of artificial respiration - refer to your notes.
8. Attend a lecture/discussion of the Silvester method of artificial respiration.

LEARNING ACTIVITIES (continued):

9. View visuals of the Silvester method. Take notes and list the dangers in using this method.

10. With two others practice the Silvester method of artificial respiration and the changing of operators.

STUDENT REFERENCE:

The back pressure method of artificial respiration should be used where circumstances, such as a head injury, prevent the use of mouth-to-mouth resuscitation.

The Holger-Nielson (back-pressure arm-lift) method of artificial respiration relies on manual pressures to initiate the normal rising and falling of the chest.

1. The position of the person injured and the first aid person is important.

2. Artificial respiration takes place in two phases: Compression and Expansion.

3. The person giving first aid will tire when using this method for a long time. It may be necessary to relieve him.

The Shafer (prone-pressure) method relies on manual pressures to imitate the normal rising and falling of the chest. This manual pressure will force air out of the lungs. Release the pressure and air will flow into the lungs.

To administer the Shafer method of artificial respiration, proceed as follows:

1. Lay the victim face down, one arm extended directly over his head, the other bent at the elbow.

2. Turn his head toward the extended arm, so the side of his head is lying on the hand or forearm of the bent arm. The nose and mouth must be free for breathing.

## STUDENT REFERENCE (continued):

3. Kneel, straddling the victim's thighs, in a position that will allow you to place the palms of your hands on the victim's back. The fingers should rest on the ribs, the little finger just touching the lowest rib, the thumb and fingers in a natural position, with the tips of the fingers just out of sight on the sides of the body.

4. With your arms held straight, swing forward slowly, gradually placing your weight over your hands and upon the victim's back. Your shoulders should be directly over the heel of your hands at the end of the forward swing.

5. Swing backward immediately, removing the pressure completely. Wait about two seconds, then swing forward again. Repeat this double movement (compression and release) 12 to 15 times a minute.

The Silvester method of artificial respiration makes use of the muscles used in regular respiration to force air into and out of the lungs.

1. Position is important, again, to the proper administration of artificial respiration.

2. Artificial respiration should be started immediately.

3. When done properly, this treatment is hard work for the operator. He should be relived as soon as he grows tired. Changing operators should be done in a way that avoids any change in rhythm.

## EVALUATION:

Answer the following questions in writing.

1. List the three methods of back pressure artificial respiration. Give examples of when each should be used.

2. With two partners demonstrate for the examiner the correct procedure of performing each of the three methods of back pressure artificial respiration and your ability to properly change operator's.

EVALUATION (continued):

3. During your demonstration you will explain to the examiner your procedure including cautions to be used (if any) for all three methods of back pressure artificial respiration.

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## II. DUTY: First Aid & Safety

### TASK 5: Control of Bleeding

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### INTRODUCTION:

In this lesson you will hear a discussion of some basic information about the circulatory system. In particular, you will hear a discussion about the heart, clotting of blood, bleeding, and methods for controlling bleeding.

### LEARNING ACTIVITIES:

1. Attend the showing of the MESA film "Control of Bleeding" and take notes on important points.
2. Take part in a class discussion on the film "Control of Bleeding", take notes covering the terms associated with the circulatory system.
3. Be able to explain how blood flows from a wound, can be stopped or slowed down.
4. Explain how and why blood clots.
5. From your notes list the two methods of controlling bleeding.
6. Graphically illustrate blood flow from first, arteries, secondly, from veins, thirdly, from capillaries.
7. Use model or simulation to demonstrate/practice control of bleeding.

### STUDENT REFERENCE:

The loss of two pints of blood in an adult is a serious matter. At an oil site accident we must control blood loss.

The heart pumps blood throughout the body. This pumping action causes the blood to pulse. The pulse is used to measure the heart beat and can be taken at the wrist or neck.

STUDENT REFERENCE (continued):

The heart pumps the blood to the lungs where it collects oxygen, then moves it to the rest of the body.

The blood is sent through the body in large and small blood vessels called arteries, capillaries and veins.

### CLOTTING

1. When there is a cut or break in the circulatory system, the blood thickens at the wound and forms a kind of dam to stop bleeding. This is called clotting.
2. The first purpose of first aid treatment is to help the blood form clots at the site of a wound. There are several steps you can take to reduce the flow at the wound.
3. In some people, clots will not form by themselves. These people are known as "bleeders". They must be taken to a medical facility immediately.

### HEMORRHAGE OR BLEEDING

1. Not all wounds are alike. A cut artery, for instance, is more serious than an opening in the flesh where only capillaries are involved. In giving first aid it is important to recognize the differences.

### BLEEDING FROM AN ARTERY

1. When blood spurts from a wound and is bright red, an artery has been cut.

### BLEEDING FROM A VEIN

1. When dark red blood flows from a wound in a steady stream, a vein has been cut.

### BLEEDING FROM CAPILLARIES

1. When blood oozes slowly from a wound, capillaries have been cut.

## STUDENT REFERENCE (continued):

### METHODS OF CONTROLLING BLEEDING

1. Direct Pressure

   a) Place a sterile pad, clean handkerchief, cloth or bandage over the wound and press firmly with your hands.

2. Indirect Pressure

   When bleeding is severe, pressure on the wound may not be enough to stop bleeding. In this case, additional pressure on the cut blood vessel is the best action.

## EVALUATION:

Answer the following question in writing.

1. Give a verbal or written description of a wound and the bleeding, list whether the bleeding is from a vein, capillary or artery also state the method you would use to control the flow of blood.

## II. DUTY: First Aid & Safety

### TASK 6: Locate Pressure Points

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## INTRODUCTION:

This lesson relates very closely to the last lesson on control of bleeding. In this lesson you will hear a discussion and see a movie about pressure points that stop bleeding. In this lesson you will learn the definition of the term "pressure point" and how to stop bleeding by applying pressure on the pressure points.

## LEARNING ACTIVITIES:

1. From viewing the visuals and attending a class lecture/discussion, draw an outline of the body and show the location of all the pressure points.
2. With a partner develop a chart of major injuries located in different parts of the body then state the location of the pressure points.

## STUDENT REFERENCE:

A pressure point is a point where an artery comes close enough to the surface of the skin to be reached and close enough to bone so that pressure can be applied on the artery against the bone.

Remember that a wound bleeding dark red blood at a steady rate is a venous wound, and pressure should be applied further from the heart. This is because the blood is flowing toward the heart. By contrast, a wound spurting bright red blood is an arterial wound (blood flowing away from the heart), and pressure should be applied closer to the heart.

STUDENT REFERENCE (continued):

Pressure Points - There are 11 pressure points on each side of the body.

1. Head Pressure Points
   - a. Temporal
   - b. Facial
   - c. Carotid

2. Arm or Hand Pressure Points
   - a. Ulnar
   - b. Radial
   - c. Brachial
   - d. Axillary
   - e. Subclavian

3. Leg Pressure Points
   - a. Popliteal
   - b. Femoral

EVALUATION:

Answer the following question.

1. Given a description of a wound, the location, of bleeding, and color of the blood, show the location of the pressure point that would help control the bleeding (if necessary). You will be expected to explain the proper method of controlling the blood flow from the wound.

## II. DUTY: First Aid & Safety

### TASK 7: Apply a Tourniquet

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INTRODUCTION:

In this lesson you will learn another way to control bleeding. In the last lesson you learned that bleeding could be controlled by applying pressure to certain points on the body. However this may not always work, so in this lesson you will learn about bleeding control through the use of tourniquets. You will also learn that tourniquets should be used only when nothing else works to stop the bleeding.

LEARNING ACTIVITIES:

1. View visuals while attending a lecture/ demonstration; take notes as your instructor explains the technique and application. Make special note of precaution.
2. Read student reference section, list any questions you wish to be answered.
3. With a partner, practice the application of tourniquets.

STUDENT REFERENCE:

Sometimes bleeding is so severe that applying direct pressure to the wound or pressure to the correct pressure points are not effective in controlling the bleeding, thus requiring the use of a tourniquet or a constricting bandage. A tourniquet should be used only when the bleeding is so severe that methods of control do not work.

How to apply a tourniquet:

1. Use a strong, wide piece of cloth.
2. Select a solid, padded object to place over the pressure point.

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STUDENT REFERENCE (continued):

3. Tie a half knot on the outside of the arm or leg.
4. Insert a strong stick over the half knot.
5. Twist to apply pressure.
6. Loose the tourniquet after 10 minutes.

EVALUATION:

Answer the following question in writing.

1. Given a verbal description of a wound stating location, type of uncontrolled bleeding, and color of blood, use "Resusci-Anne" to demonstrate how you would control the bleeding and explain your procedure.

## II. DUTY: First Aid & Safety

### TASK 8: Apply Constricting Bandages

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### INTRODUCTION:

In this lesson you will learn about a final method of bleeding control. This method - constricting bandages - is similar to both the pressure point method and the tourniquet.

### LEARNING ACTIVITIES:

1. Attend a showing of the film "Physical Shock".
2. Make a list of words and definitions that pertain physical shock.
3. Attend a class question and answer session covering the cause, effects and treatment of physical shock.
4. Practice the application of constricting bandages.

### STUDENT REFERENCE:

As an alternative to using a tourniquet to stop bleeding use a constricting bandage.

1. When direct pressure does not stop bleeding, a constricting bandage may be applied.
2. Pressure is applied with a square knot over the artery or vein at a point near the wound.
3. The same technique of application and precautions used in tourniquet application should be followed with a constricting bandage.

**EVALUATION:**

Answer the following questions in writing.

1. List the seven (7) causes of physical shock.

2. Describe how vital organs act when affected by shock.

3. State the systems of shock.

   a. Physical    b. Emotional

## II. DUTY: First Aid & Safety

### TASK 9: Identify and Treat for Physical Shock

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**INTRODUCTION:**

The subject of this lesson is shock. In the lesson you will hear a definition of the term shock and see a film on what it is all about. You will also hear a discussion of the symptoms and causes of shock.

**LEARNING ACTIVTIES:**

1. While viewing visuals develop a list of procedural steps for treating physical shock victims.
2. With a partner practice the treatment of physical shock.

**STUDENT REFERENCE:**

Physical shock is a serious condition that occurs to some degree after every serious injury. If not treated, shock may result in death in cases where the injuries by themselves would not prove fatal. It is important for you to recognize the symptoms of physical shock and know how to treat it. In fact, it is strongly recommended that treatment for shock be given after serious injury, thus making it important for the petroleum worker to know how to give it.

Shock is the upsetting of the nervous system, particulary the system that involves the heart, lungs, digestive tract and excretory organs.

During shock the vital organs are affected. The heart beats rapidly and weakly. The respiratory system becomes over-active and inefficient.

STUDENT REFERENCE (continued):

The causes of physical shock are:

1. Severe loss of blood
2. Intense pain
3. Severe or extensive injury
4. Burns
5. Anxiety
6. Poisonous gases
7. Sight of blood or injury to fellow worker.

THE SYMPTOMS OF SHOCK

1. Physical changes observed during shock are:
    a. *A dull, chalk-like appearance to the victim's skin, regardless of color.
    b. *An anxious or dull expression.
    c. Closed or partially-closed eyelids.
    d. *Shallow, irregular breathing.
    e. *Weak, rapid pulse.
    f. *Cold, moist skin.
    g. Shaking of the arms and legs if chilled.
    h. Vomiting
2. Emotional changes which may result are:
    a. *Partial or total unconsciousness.
    b. *Slow response to questions, or unrelated answers.

EVALUATION:

Answer the following question in writing.

1. This evaluation will cover three areas of instruction. You will receive a description of a victim. There will be a detailed description of the accident, victim's injuries, location of victim. You are the first person to reach the victim. Explain what action you would take until medical aid arrives. For each action you take in the care of the victim, list the procedural steps.

## II. DUTY: First Aid

### TASK 10: Demonstrate and Explain the Treatment for Physical Shock

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### PERFORMANCE OBJECTIVES:

In this lesson you will hear a step-by-step discussion of the best way to treat a person for physical shock.

### LEARNING ACTIVITIES:

1. While viewing visuals develop a list of procedural steps for treating physical shock victims.
2. With a partner practice the treatment of physical shock.

### STUDENT REFERENCE:

Once the reactions to physical shock have been detected, treatment should follow immediately. A person in shock needs attention. If attention is delayed, death or further complications may follow.

Treatment for shock:

a. Lay the victim flat.
b. Elevate feet six inches.
c. Clear mouth of foreign objects.
d. Loosen clothing.
e. Keep the victim warm and dry.

## STUDENT REFERENCE (continued):

1. Positioning the person properly is important.
2. Clear the person's mouth.
3. Be sure the tongue is forward.
4. Loosen tight clothing.
5. Keep the person warm and dry.
6. If the person is sick to his stomach and throws up, turn his head to one side.
7. Stimulants may be given to the person if he is conscious.
8. If medical help will be delayed, give the person a half-glass of water at 15 minute intervals.
9. If the person is unconscious, give a stimulant by inhalation.
10. Getting the person to inhale oxygen is often helpful in cases of shock.
11. Keep the person down and quiet.
12. Watch for relapse and renew shock treatment immediately.

## EVALUATION:

Answer the following question in writing.

1. This evaluation will cover three areas of instruction. You will receive a description of a victim. Given the accident, victim's injuries location of victim. You are the first person to reach the victim. Explain what action you would take until medical aid arrives. For each action you take in the care of the victim, list the procedural steps.

## II. DUTY: First Aid & Safety

### TASK 11: Identify Cause and Explain Treatment of Fainting

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### INTRODUCTION:

In this lesson you will hear a discussion of fainting. In the ocurse of this discussion you will hear a definition of fainting, a discussion of the primary causes of fainting, its symptoms and treatment. You will probably notice some similarities between this discussion of fainting and the last lesson on physical shock.

### LEARNING ACTIVITIES:

1. Attend a lecture/discussion covering cause, symptoms, and treatment of fainting.

2. In a simulated setting, treat person for shock.

### STUDENT REFERENCE:

Fainting is a mild form of physical shock and is one of the more frequent occurrences that requires first aid.

Fainting is a temporary loss of consciousness due to an inadequate supply of oxygen to the brain; it is a mild form of physical shock.

It may be caused by:

1. Injury.
2. Physical or mental exhaustion.
3. Excessive heat.
4. Lack of air (oxygen).
5. Intense emotion.

STUDENT REFERENCE (continued):

The symptoms of fainting are:

1. Dizziness and complaints by the victim that he sees "spots" before his eyes.
2. Perspiration on the forehead.
3. Weaving or sinking to the floor.
4. Weak and rapid pulse.
5. Shallow breathing.

Treatment for fainting should be given immediately.

1. Lay the victim flat, or lower his head below the rest of his body.
2. Cleanse his mouth.
3. Loose clothing at the neck.
4. Give aromatic spirits of ammonia or smelling salts by inhalation.
5. Keep the person quiet and warm.

When the person recovers consciousness, do not allow him to sit up for at least one half hour.

If unconsciousness is prolonged, give treatment for shock and call for a doctor.

EVALUATION:

Demonstrate the following procedure.

1. Demonstrate for your examiner the treatment of a fainting victim.

## II. DUTY: First Aid & Safety

### TASK 12: Treat Open Wounds

### INTRODUCTION:

The subject of this lesson is open wounds. In the discussion of this topic you will hear about the dangers of blood loss and infection in the open wounds. Four types of open wounds will be defined. Also, you will see some slides and hear a discussion of step-by-step procedure for treating open wounds.

### LEARNING ACTIVITIES:

1. View the MASA film "Open and Closed Wounds".
2. Develop in your notes, a listing of the four kinds of open wounds and a chart showing the type of wound, cause, characteristics, and special concerns.
3. Practice bandaging simulated open wounds.

### STUDENT REFERENCE:

The greatest dangers with open wounds are the loss of blood and infection. The aim of first aid in treating open wounds is not to repair the damage but to counteract these two dangers. The trainee has already learned how to control bleeding and in this lesson he will learn how to prevent or control infection.

Given verbal or pictorial descriptions of the following terms, you will correctly match the terms to their descriptions:

1. Open wound
2. Abrasion
3. Incision
4. Laceration
5. Puncture wound

## STUDENT REFERENCE (continued):

Four kinds of open wounds:

1. Abrasions
2. Incisions
3. Lacerations
4. Punctures

When treating open wounds your main concerns are to stop the bleeding and to prevent infection.

1. First, stop the bleeding!

2. Wipe away foreign matter from the wound using a piece of clean material.

3. Cover the entire wound with a sterile bandage compress or sterile gauze.

## EVALUATION:

Answer the following question.

1. Given verbal or pictorial description of the open wound terms, you will correctly match the terms to their descriptions.

II. DUTY: First Aid & Safety

TASK 13: Dressing Wounds

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## INTRODUCTION:

The subject of this last lesson in the unit is various methods for dressing wounds. In the course of this lesson you will see a movie and hear a discussion that will give you a step-by-step procedure for dressing wounds on various parts of the body.

## LEARNING ACTIVITIES:

1. Identify materials required to dress all body wounds.
2. You will be required to correctly bandage:
   a. Head wounds
   b. Eye injuries
   c. Wounds of the nose
   d. Upper body wounds
   e. Wounds of the trunk
   f. Groin injuries
   g. Wounds of the crotch
   h. Hip wounds
   i. Lower extreme injuries

## STUDENT REFERENCE:

1. The purpose of bandages is to stop the bleeding and to prevent infection in the wound.
2. Bandages for wounds to the head.

   a. Bleeding from the scalp, temple, ear, or face.

   b. Severe wounds and bleeding of the scalp.

   c. Wounds of the forehead or back of the head.

STUDENT REFERENCE (continued):

- d. Injuries to the eye.
- e. Wounds bleeding of the nose.
- f. Wounds and bleeding of the chin.
- g. Wounds and bleeding of neck or throat.

3. Wounds of the upper body.

   - a. Wounds and bleeding of the shoulder.
   - b. Wounds and bleeding of the armpit.
   - c. Arm torn from the body.
   - d. Dressing for an amputated arm.
   - e. Wounds and bleeding of the arm, forearm and wrist.
   - f. Treatment for wounds of the elbow.
   - g. Wounds and bleeding of palm and back of hand.

4. Wounds of the trunk (chest, abdomen, groin and hips).

   - a. Wounds of chest.
   - b. Wounds and bleeding of back.
   - c. Wounds and bleeding of the abdomen or side.
   - d. Wounds and bleeding of the lower abdomen, lower abdomen, lower back or buttocks.
   - e. Wounds and bleeding of the groin.
   - f. Wounds and bleeding of the crotch.
   - g. Wounds and bleeding of the hip.

5. Wounds of the lower extremeties.

   - a. Wounds and bleeding of the thigh.
   - b. Dressing for an amputated thigh or leg.
   - c. Wounds and bleeding of the knee.
   - d. Wounds and bleeding of leg.
   - e. Wounds and bleeding of the ankle.
   - f. Wounds and bleeding of the foot.
   - g. Extensive wounds and bleeding of the foot.
   - h Wounds and bleeding of the toe.

EVALUATION:

Perform the following activity correctly.

1. Correctly dress head wounds, injured eyes, arm wounds, leg wounds, foot wounds, hand wounds.

# II. DUTY: First Aid & Safety

## TASK 14: Define Closed Wounds and Practice Treatment of Closed Wounds, Sprains and Hernias.

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### INTRODUCTION:

In this lesson you will see a film and hear a discussion on closed or internal wounds. The film will contain a review of an earlier lesson on open wounds. The film will contain a review of an earlier lesson on open wounds. The main point of this lesson is that you should learn to recognize a number of closed wounds.

### LEARNING ACTIVITIES:

1. Attend a showing of the MASA film "Open and Closed Wounds".
2. Develop a chart showing types of closed wounds, characteristics, and treatment.
3. Practice treating persons with closed wounds.

### STUDENT REFERENCE:

Closed wounds, although not life-threatening conditions, can be very painful. Depending on the seriousness of the injury, closed wounds could stop a peron's movement of his arms or legs.

Closed wounds are injuries that happen without breaking the skin. The damage is to the skin tissue below the surface skin.

1. Bruises are cause by contact with blunt objects.
2. Strains happen when muscles or tendons have been overworked or stretched.
3. Sprains happen when ligaments and other tissue around a joint are stretched or torn. They are caused by a sudden twist of the joint.

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4. Rupture or Hernia is usually the pushing out of an intestine through the wall of the abdomen.

## TREATMENT OF CLOSED WOUNDS

Treatment of closed wounds is aimed at stopping plan and increasing the movement of the part injured.

Bruises - Apply cold appliances (ice bags or cold towels). Lift the bruised area to limit the flow of blood. Check for other injuries (fractures or dislocations).

### Strains

1. Place the person in a comfortable position.

2. Apply dry heat (a heated object wrapped in a towel or blanket).

3. Rub the injury with warm alcohol or witch hazel.

4. Keep injured part still.

### Sprains

1. Keep the joint still in an elevated position.

2. Use cold things such as moist, cold towels or an ice pack to relieve pain.

3. Bind the joint firmly with a cravat bandage.

4. Never strap a sprained joint with adhesive tape. Leave this action to a doctor.

5. A sprain will often act like a fracture. If there is any doubt, treat the injury as a fracture (treatment of fractures will be covered in a later section).

## TREATMENT OF A HERNIA

### Rupture or Hernia

1. Tie thighs together.
2. Place cold appliance over rupture.
3. Place a pillow under the knees.

**EVALUATION:**

Answer the following questions in writing..

1. State the definitions of a closed wound.
2. Given a description of a closed wound, demonstrate the proper treatment.

## II. DUTY: First Aid & Safety

### TASK 15: Remove Foreign Objects

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## INTRODUCTION:

In this lesson you will learn what to do if you or one of your buddies has a foreign object of some type in his eyes, ears, nose or throat.

## LEARNING ACTIVITIES:

1. Attend a lecture/demonsration covering the proper treatment of foreign objects in the eye, ears, nose, throat or windpipe.
2. With a partner practice the proper treatment of foreign object injuries to the eye, ears, nose, throat or windpipe.

## STUDENT REFERENCE:

Foreign objects in the eyes, ears, nose and throat or windpipe can be very painful and uncomfortable. These objects may lead to infection if not treated quickly. If they enter the air passage, there is a danger that the supply of oxygen will be cut off. Treatment depends on the location of the object.

## EVALUATION:

Perform the following activity correctly.

1. Demonstrate your abilities to administer first aid to a person suffering from a foreign object injury.

## II. DUTY: First Aid & Safety

### TASK 16: Identify and Treat Burns

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### INTRODUCTION:

In this lesson you will hear a discussion of nonchemical burns. In the course of this discussion you will be learning the difference between scalds and first, second and third degree burns and methods for treating burns.

### LEARNING ACTIVITIES:

1. View the MASA film covering "Burns".
2. Participate in a class discussion, lead by your instructor, on the MASA film "Burns".
3. In your notes construct a Burn Classification Chart.
4. Make a list of the general care for burns and scalds. (Both chemical and nonchemical).
5. Using your notes, and with a partner, practice the proper techniques for treating burns and scalds.

### STUDENT REFERENCE:

The main danger with burns is infection. First aid treatment for nonchemical burns is aimed at keeping air away from the burned area, relieving pain, and stopping shock.

Burns are injuries to the skin caused by dry heat such as fire, electricity, friction and heat objects.

1. Scalds result from contact with wet heat - hot solutions.

STUDENT REFERENCE (continued):

2. First degree burns are the least serious.

3. Second degree burns affect the under skin and cause blisters.

4. Third degree burns destroy the skin and damage the tissues underneath.

First aid treatment for nonchemical burns and scalds is aimed at keeping air off of the burned area, relieving pain, reducing shock and stopping infection.

EVALUATION:

Answer the following question in writing.

1. From a list you will select the corrrect procedure for the treatment of both chemical and nonchemical burns.

## II. DUTY: First Aid & Safety

### TASK 17: Identify Fractures, Administer Treatment Using a Splint

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INTRODUCTION:

In this lesson you will see a movie and hear a discussion about the nature of bone fractures and dislocations. In the course of this discussion you will hear a definition of several terms related to fractures and dislocations. In the lesson you will also learn how to use a splint.

Take part in a detailed discussion of the steps that you should use to treat a fracture that could occur to various part of the body, from the head to toe.

LEARNING ACTIVITIES:

1. Ater you have viewed the MASA film entitled "Fractures and Dislocations", complete your notes listing definitions, types, and symptoms of fractures and dislocations.
2. Attend a demonstration covering the use of splints.
3. With your partner practice applying splints.
4. You will attend a lecture/demonstration explaining the treatment of fractures.
5. As you watch the instructor's demonstration; list in your notes type of fracture, materials required for treatment, and procedure to be used in treatment. Practice the treatment of fractures with a fellow student.

STUDENT REFERENCE:

Fractured or dislocated bones are serious injuries. They often cause loss of movement to the injured limb and loss of income to the worker. Correct first aid treatment can prevent complications and shorten recovery time.

## STUDENT REFERENCE (continued):

A fracture is a broken bone. There are two types: simple fractures and compound fractures.

The symptoms of a fracture are:

1. Pain in the region of the fracture.
2. Loss of function (no movement).
3. Deformed looking limb.
4. Moderate or severe swelling.

## USING A SPLINT

The purpose of a splint is to support, protect and stop movement.

The requirements of a splint are:

1. It must be firm and rigid.
2. It must be long enough to prevent movement on either side of the fracture.
3. It should be as wide as the thickest part of the fractured limb.
4. It should be well padded to protect the skin.

Two types of splints:

1. Plastic inflatable splints that are inflated over the injury.
2. Common things used as splints such as wood planks, handles, drill stems, roof bolts.

## DISLOCATIONS

Where the bones come together without forming a bony union, a joint is formed. There are three types in the body:

1. Immovable joints.
2. Joints with limited motion.
3. Freely movable joints (jaw, elbow, hip and toes).

STUDENT REFERENCE (continued):

Dislocation - In a dislocation, the ligaments holding the bones in the proper position are stretched and sometimes torn loose.

The general symptoms of a dislocation are:

1. Rigidity and loss of function.
2. Deformity or irregularity of the affected joint.
3. Pain at the joint.
4. Moderate or severe swelling around the joint.

In first aid, no attempt should be made to reduce dislocations, except dislocations of the lower jaw, fingers and toes. Where medical help is readily available, do not attempt to reduce even these dislocations.

## TREATMENT OF FRACTURES AND DISLOCATIONS

The ways of treating fractures are given according to type and location, beginning with the skull and ending with the foot.

1. Fractures of the Skull

    a. The skull may be fractured without a visible wound of the scalp.

2. Fractures of the Nose

3. Fracture of the Upper Jaw or Cheekbone

    a. Treat as a wound of the face.

4. Fracture of the Lower Jaw

5. Fracture of Collarbone

6. Fractures of the Upper Third of the Arm

7. Fractures of the Lower Two-Thirds of the Arm, Elbow, Forearm, or Wrist

8. Fractures or Crushing of the Hand or Fingers

9. Fracture of the Ribs

10. Fractures of the Spine

STUDENT REFERENCE (continued):

11. Fractures of the Pelvis or Hip
12. Fractures of the Thigh and Knee
13. Fractures of the Kneecap
14. Fractures of the Leg or Ankle
15. Fractures (or Crushing) of Bones of the Foot and Toes

Treatment for Dislocations - The proper treatment for a dislocation includes the application of dressing and splints so that the affected parts are immobilized in the line of deformity.

EVALUATION:

Answer the following questions in writing.

1. You will be asked to indicate the difference in a fracture and a dislocation.
2. Along with fellow student who has a simulated fracture or dislocation; you will administer required first aid techniques.

# II. DUTY: First Aid & Safety

## TASK 18: Transport the Injured

### INTRODUCTION:

In this lesson you will hear a discussion about moving injured persons. You will be asked to learn what precautions should be used when injured persons are moved, as well as a particular technique for lifting an injured person.

### LEARNING ACTIVITIES:

1. Attend the showing of the MASA film "Transporting". Take notes listing the sequence of movement of an injured person.
2. Discuss, practice and demonstrate the three man lift and carry and stretcher board method of transport injured person.

### STUDENT REFERENCE:

Transporting the injured person to medical help is an important task. Every pertroleum worker must know and be able to demonstrate the best way for stopping further injury, shock or pain.

THREE-MAN LIFT AND CARRY

STRETCHER BOARDS

### EVALUATION:

Demonstrate the proper means of transportation.

1. Given visual examples of correct and uncorrect ways of transporting an injured person from a well site, you will be able to recognize the correct ways.

## II. DUTY: Safety

### TASK 19: Practice Fire Safety

INTRODUCTION:

In this lesson you will view the slide presentation "First-Aid Fire Training". In the slide presentation you will learn the methods of extinguishing a spill fire, a spill fire with an obstacle, a pit fire, the pit fire with an obstacle, an multi-level flammable liquid fire, a liquid pressure fire, the over head flammable liquid pressure fire, and escaping combustible gas fire.

The first aid for burns will be reviewed and the film covering burns will be showed again.

LEARNING ACTIVITIES:

1. Participate in a classroom discussion lead by your instructor on first, the slide presentation "First-Aid Fire Training", and second, on the film "Burns". You will be expected to take notes on the visual aid presentations for future reference and you will, with a partner, practice the proper technique for treating burns.
2. You will observe the proper techniques of extinguishing a pit fire and a spill fire - which will be performed by the Fire Company.
3. Practice extinguishing a pit fire and a spill fire.

STUDENT REFERENCE:

As soon as you notice a fire you should summons help by telephoning or sounding an alarm. Locate a fire extinguisher and proceed to the upwind side of the fire, stop, "charge it", and move approximately 8 feet near the edge of a spill fire. Aim the stream just short of the near edge of the fire and start a side to side sweeping action across the width of the fire. You now advance forward as

STUDENT REFERENCE (continued):

fast as the extinguishing action will permit. Do not step into the spill and maintain the side to side sweeping action until the fire is out. When the fire is out, you should stand by for a few minutes to make sure there is no chance of a flashback.

Any fire with an obstacle in it will take two people to extinugish it. Each person will need to be responsible for 2/3's of the fire and be alert as to the other person's actions.

To extinguish a multi-level flammable liquid fire always approach the fire on the upwind side. Start at the ground level and work your way up as fast as control of the spill fire will permit. Once the fire is out, be sure to stand by for a few mintues to guard against flashback.

For the successful extinguishment of a flammable liquid pressure fire you should start at ground level and work up to the source.

To extinguish an overhead liquid pressure fire you should direct the extinguisher at the source and work your way down to the ground and then with a side to side sweeping action extinguish the ground spill. This fire is difficult for one person and may take more than one extinguisher.

It is recommended that you not extinguish a fire of combustible gas under pressure unless you will be able to shut off the feed supply after doing so. If you put the fire out but let the gas continue to escape, then the gas might fill a whole valley and reignite making a fire that could be several hundred yards in all directions. If you determine that the fire should not be extinguished in the first place than water should be directed at the equipment to keep it from overheating. If and when this type of fire is extinguished, a person should start upward and direct the extinguisher stream into the flowing gas. The flowing gas will carry the extinguishing agent out to the point of combustion. Once the fire is out, you should stand by for a few minutes to guard against flashback or reigniting.

BURNS - The main danger with burns is infection. First aid treatment for nonchemical burns is aimed at keeping air away from the burned area, relieving pain, and stopping shock.

STUDENT REFERENCE (continued):

Burns are injuries to the skin caused by dry heat such as fire, electricity, friction and heat objects.

1. Scalds result from contact with wet heat - hot solutions.

2. First degree burns are the least serious.

3. Second degree burns affect the under skin and cause blisters.

4. Third degree burns destroy the skin and damage the tissues underneath.

First aid treatment for nonchemical burns and scalds is aimed at keeping air off of the burned area, relieving pain, reducing shock and stopping infection.

EVALUATION:

Answer the following questions in writing.

1. From a list of different steps to extinguish 3 types of fire, you will select the correct method.

2. Together with a fellow student, develop a list of correct procedures for the treatment of nonchemical burns.

## II. DUTY: First Aid & Safety

### TASK 20: Protect Your Hands

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### PERFORMANCE OBJECTIVES:

In this lesson you will learn some of the dangers to your hands that exist around a rig and how to prevent hand injuries.

### LEARNING ACTIVITIES:

1. View the slide presentation about "Hand Injuries in Drilling".
2. Review in class the ways to prevent hand injuries.
3. Review the first aid for hand injuries.

### STUDENT REFERENCE:

Drilling can be a high risk business. Risks are taken by the men who invest capital in the rig and its equipment and to the men who work on the rig. Minor injuries to the hands like cuts and scratches can occur at anytime on the rig, so wear gloves at all times to protect your hands. Gloves can protect the hands from friction burns too. Holding wire rope without wearing gloves can cause such an injury. To be safe, wear safety gloves at all times on the rig.

Unsafe working conditions around the rig place the entire crew in jeopardy. Accidents can happen, so watch for unsafe conditions around the drilling rig and correct them to prevent accidents.

To safely protect your hands while drilling, keep these safety factors in mind: INSPECT the rig, rig equipment, hand tools, and safety equipment. Be aware of pinch points

STUDENT REFERENCE (continued):

that can trap fingers between two moving pieces of equipment. Making up or breaking out joints of drill pipe with the spinning chain is an operation that requires quick, accurate placement of the hands in an extremely hazardous area. Rolling drill pipe on or off the rack is another dangerous area for the hands because of pinch points. Be aware at all times when handling drill pipe. Latching tongs involves the use of the hands too. Improper placement of hands on the latch handle can lead to a serious injury. Elevator latches and bails can be dangerous. The hands can must be used in this operation. Make sure they are used safely. Hand injuries may also occur during operations that require adjustments or replacements to chains or to belts. Use caution when performing this type of maintenance to rig machinery. Hand injuries in drilling can occur at anytime, but they can be avoided by using common sense, by wearing gloves, by inspecting the rig and rig tools, and keeping alert to the hazards that can cause hand injuries.

EVALUATION:

Answer the following questions in writing.

1. Name 7 ways to avoid hand injuries around the rig.
2. Demonstrate the proper first aid for hand injuries.

II. DUTY: First Aid and Safety

TASK 21: Review Safety Tips for New Employees

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INTRODUCTION:

In this lesson safety on and around trucks, tanks, well heads, and pumping units will be discussed. Fire hazards, safety equipment and signs will also be covered in order that you will know what to look for in preventing accidents.

LEARNING ACTIVITIES:

1. View a slide presentation "Lease Safety Tips for New Employees" will be viewed.
2. A the safety consultant from one of the local companies will give a safety presentation to the class.

STUDENT REFERENCE:

You should be careful of pinch-points on trucks and watch out that tools are not dropped from the truck or onto your feet. The snatch block is a real danger to fingers and it is recommended that you wear gloves with leather palms when working with wire rope.

The A-frame or truck mast could fall, always be alert and stay out from under the mast or loads on the mast.

It is recommended that you keep the truck mast at least 15 feet away from any power lines because electricity can jump the gap.

Be sure that the hold down chains or lines are in good shape and in their proper place.

Always pull on a boomer so there will be no chance that it will hit you in the face.

STUDENT REFERENCE (continued):

If there are acetylene and oxygen bottles on the truck, be sure they are secured and handle them carefully. Never oil or grease any fittings of an oxygen bottle because it might blow up. Always store acetylene bottles upright and away from oxygen bottles so there will be less chance of explosion.

If you use the cutting torch you will always wear goggles, gloves, and long sleeves to protect you from burns. Be alert to fire hazards whenever using a torch.

Always ride inside of the truck; never on top, fenders, bed or sides.

Around tanks you should guard against stumbles and falls. It is unwise to walk on top of tanks because even if the top looks strong, you might break through and you are cannot to swim in oil.

Do not open valves on tanks unless you are told to do so and then open them slowly since the surge of pressure might burst the tank seams or lift the top.

When using the stairway or ladders to get to tanks you should use the handrail, take one step at a time and do not skip any steps.

Always use the walk way to get over pipe and not take a chance of slipping or falling through the pipes when climbing over them.

Do not attempt to work on any electrical equipment, always let electricians do this kind of work. Watch out for buried lines that are sometimes hard to see so you do not cut into them by accident.

Shut all machinery down if you remove the safety devices from them and do not start them up again until all guards are back in place.

When working around stacked pipe, always work from the ends so pipe will not roll off and crush you. Watch out for pinch-points and be sure that the pipe is blocked or chained to keep it from rolling.

STUDENT REFERENCE (continued):

When working on pumping units you should always watch out for the counterweights. Make sure the counterweight guards are in place. If the guards are removed always chain the guards down so they can not move and hit someone. Do not depend on the break to hold a pumping unit and you should make sure all belt guards are in place when the unit is operating.

If a pumping unit is automatically controlled, turn the switch to off so it can not start up while you are working on the unit.

Use all safety equipment such as goggles, hard hats, gloves, safety shoes, ear protection, protective clothing, and other items necessary for the working conditions.

It is wise to know the location of fire extinguishers and how to use them. Most fires will start out small and quick action on your part can prevent a major fire.

If you can not find any identification on a closed or sealed container, it should be treated as dangerous until you know what the contents are.

Look for all danger signs or warning signs and follow the precautions or instructions given. They have been put up for a good reason, to make your job safer.

EVALUATION:

Answer the following questions.

1. Always wear gloves with leather palms when handling wire rope. (True or False).

2. There's a load suspended from the A-frame at the back of your gang truck. One of the persons you're working with drops a wrench under the load and starts to reach for the wrench. What should you do?

   a. Stand back so he can get the wrench quickly?
   b. Rush over and pick up the wrench yourself.
   c. Don't let anyone try to pick up the wrench until the load is on the ground and the truck is out of the way.
   d. Stay clear and let the boss pick up the wrench.

3. Gang trucks should always be parked at least 15 feet away from the nearest power line. (True or False).

## II. DUTY: First Aid and Safety

### TASK 22: Practice Perform Rig Inspection

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### INTRODUCTION:

In this lesson you will be taught how to accomplish a rig inspection program. You will be the basic guidelines for setting up an inspection program. You will learn that a rig inspection program does more than prevent accidents and you will learn who is responsible for a rig inspection.

### LEARNING ACTIVITIES:

1. Attend a showing of the slide/tape presentation of "Rig Inspection".
2. As a class, critique the slide/tape on "Rig Inspection" and from your notes from the class on "Petroleum People", you will decide who is responsible for the various areas of the inspection.
3. Work in small groups and develop an inspection program for one of the following: Roustabout, Tool Pusher, Driller, Derrickman, Motorman, Rig Electrician.

### STUDENT REFERENCE:

1. Rig-Floor Area

The rig-floor is the site of most of the interaction between the crew and the drilling equipment. And, regardless of size, all rig-floor equipment must be inspected and properly maintained for a safe working environment. The rig floor itself should be level and properly secured. Excess oil, grease, and drilling fluid should be cleaned up as as soon as possible.

STUDENT REFERENCE (continued):

Rig-floor equipment (the tongs, for example) should be thoroughly inspected. Check for cracks in the jaws, and look closely at the tong for signs of wear or abuse. The same goes for the snub line. The cathead needs the same attention. The hand tools should also be part of the rig-floor inspection.

Wire rope is a piece of equipment used extensively on the rig-floor. It serves as the drilling line, it serves for various slings that are used on the rig, and it is also the line on the air hoist. The deadline anchor and the wire-rope clips that brace it should be checked. The air hoist should have a guard to protect the operator. And, a line guide on the hoist can prevent the wire rope from becoming tangled.

The mousehole when not being used, should be covered to prevent accidents.

The entire rig-floor lighting system should be checked for adequacy. The rotary hose should be part of the rig-floor inspection too.

Machines with moving parts are located in various places around the floor. Be sure that they are all properly guarded.

2. The Derrick

Examine the derrick ladder. A freely accessible derrick ladder is extremely important. Each section of the ladder should be examined for alignment, proper mounting, and any damage. Safety belts are required when using the derrick ladder or when working 10 feet or more above the rig floor. The elevators are not for lifting people up to the monkeyboard. That's the reason for the derrick ladder.

The monkeyboard should have metal guards around the sides, be level and free of tripping hazards, and should contain no loose tools that could be kicked off and hurt personnel below.

The sheave assembly should be in good condition and be positioned to prevent friction wear.

The crown housing should be kept clean. The hoisting chain should be inspected to assure it is in good condition. And, since drilling goes on twenty-four hours a day, derrick floodlights are needed.

3. The Generators and Electrical System

First, inspect all V-belt, sheave, and shaft guards to assure that they are in place. Next, look at all electrical connections and conductors for proper mounting, protection, and grounding. Switch boxes and connector boxes should also be in place. Portable electric tools should be provided with the proper means of grounding.

The generator and electrical systems involve the entire rig system of lighting. Lockout procedures should be used when working on electrical or mechanical equipment.

4. Stairs and Walkways

All rig-floor and motor-floor stairs should be secured at the upper end of the stairs. The rig stairs should be set at the proper angle to ensure that the treads are level. Make a general check of all stairs to see that they are in satisfactory condition. Where it's possible, handrails should be provided on both sides of the stairs or walkway. Check out area for tripping and slipping hazards such as grease, oil, drilling fluid hoses, and cables. Keeping the stairways and walkway clean makes a safer rig for everyone.

Everyone should have a hard hat. Keep extras on hand for visitors to the rig. Safety shoes with steel toes are also needed. Proper eye

STUDENT REFERENCE (continued):

protection is needed. Sufficient first-aid supplies and stretchers should be maintained on the rig, along with an approved first-aid manual.

Wearing jewelry on the rig is just not safe. Rings, watches, and other personal items should be removed before working on or around the drilling rig.

The fire extinguishers located at various points should be maintained in sufficient number and should be inspected regularly for proper operation.

CB radios and other two-way communications systems should be in good working order. Emergency frequencies should be posted. All two-way radios should be turned off, however, during perforating operations and at other times when explosives are being used. It's dangerous-even for a CB nut!

Drill pipe and casing should be chocked or tied down when on the pipe rack. Serious hand injuries can result if one pipe rolls toward another and traps a hand that might be in a pinch-point area.

EVALUATION:

Answer the following questions in writing.

1. Name 10 items you should inspect on a rig in order to insure safe working areas?
2. What preventive items before you go to work on a drilling rig, will you want to be sure that you have in order to protect yourself?
3. To further protect yourself while working, what items should you not wear?
4. Develop a checklist for an inspection program.

## II. DUTY: First Aid & Safety

### TASK 23: Identify the Requirements for Fire

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INTRODUCTION:

In this lesson you will see what can happen to persons and equipment when flammables and combustibles ignite. You will learn that you are what safety is all about. You will learn the ingredients for fire. You will be taught the flammables and combustibles you will come in contact with on or around the drilling rig. You will learn the definition of "flash point". You will be given a list of Safety Factors for handling and storing flammables.

LEARNING ACTIVITIES:

1. Attend the slide/tape showing of "Safe Handling and Storage of Flammables and Combustibles".
2. You will graphically demonstrate the three requirements for fire, and give examples of what, where, and how they would be around a drilling rig.
3. Read, study and prepare 2 questions about the student reference material.

STUDENT REFERENCE:

While working on a drilling rig, you'll come in contact with many kinds of flammable and combustible substances, most of which are derived from crude oil and take the form of gases, solvents, fuels, and oils. From these we get other such potentially dangerous substanes as propane, paint, gasoline, and lubricating oil. These substances are hazardous if not handled carefully. So the first thing to know is why they are dangerous.

Three things must be present for combustion or fire to take place: heat - in any number of forms, oxygen, -a basic part of the air we breathe; and fuel - any material that burns easily. All fuels must in the form of a gas before they can mix with oxygen, also a gas, to create a burnable mixture. This mixture is called vapor. A fire occurs when the fuel vapor is ignited, not the fuel itself. Fuels in a normal gaseous state, like propane and natural gas, mix readily with oxygen and are therefore easily ignited. The next ingredient needed for a fire is oxygen, which makes up about 21% of the air we breathe. Any fire will burn more quickly and intensively in an oxygen-enriched atmosphere or in places where the air supply is quickly replenished. Finally, heat is needed to complete the triangle. Heat may come from: flames-like matches, torches, stoves, and burnoffs; sparks-from electrical devices or static electrical discharges; friction-from abrasive surfaces like a shoe nail striking concrete, mechanical brakes, or a grinding wheel; chemical heat-from the mixture of chemicals, like oil and cloth, or pure oxygen and oil; radiant heat-like heat from the sun, heaters, ovens, and exhaust pipes.

By combining fuel, oxygen, and heat, we can derive a measure of flammability known as the flash point. Flash point is the temperature at which a combustible chemical gives off enough vapor to be ignited by a small flame or spark. Knowing the flash point gives you a fair indication of how dangerous the substance is. For instance, a flash point below 100 degrees fahrenheit or 37 degrees Celsius signifies a flammable substance. A flash point above this temperature indicates a combusitble substance. Therefore, the lower the flash point, the more dangerous the substance. The exact flash point of a flammable liquid may vary as much as 30 degrees, depending on its chemical makeup and other conditions. As you can see, these common liquids would be at or near their flash points during normal rig operating temperatures. Incidentally, the words flammable and inflammable mean the same thing. Combustible liquids, those with a flash point above 100 degrees Fahrenheit, may not be considered as dangerous as flammables, but they should always be handled cautiously, especially when used at temperatures close to their flash point. Products such as paints, solvents, glues, aerosol sprays, and gas cylinders may also contain flammable or combustible substances. Whether a substance is flammable or combustible should make no difference in the way it is treated. Once ignited, both produce the same end result: FIRE.

How safely you handle and store flammables depends largely on five factors: fuel, oxygen, vapor, heat, and other fuels. The first two, fuel and oxygen, are the most constant, since they are always present when you handle or store flammables. On a drilling rig, the most common type of flammable fuels are in the form of a liquid or gas.

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STUDENT REFERENCE (continued):

Vapor and heat are two very important aspects of fire prevention. Remember, vapor, a mixture of fuel and oxygen, is easily ignited. It is important to control vapor accumulations. Heat comes from many sources like flames, sparks, friction, chemicals, and radiant heat. The presence and reaction of other fuels can influence both the vapor and heat factors. For example, when oil and cloth are mixed together, enough heat is produced by the chemical reaction to ignite the mixture without an outside heat source. Other fuels can also cause chain reactions; that is, a fire will produce enough heat to vaporize and ignite a nearby fuel that, in turn, will ignite a third, and so on. By controlling these safety factors, you can contribute to the safe handling and storage of flammables on the rig.

EVALUATION:

Answer the following questions in writing.

1. Name three things needed to have a fire.
2. Will fuel burn if too much oxygen is present?
3. Do flammable fuels have a lower flash point than combustible fuels?
4. Which one of the following is not a safety factor for handling and storing flammables?
   A. Fuel
   B. Oxygen
   C. Vapor
   D. Ignition
   E. Heat
   F. Other Fuels
5. Are most flammables produced from crude oil?
6. Is a flammable liquid ignited easily? Why?

## II. DUTY: First Aid & Safety

### TASK 24: Proper Storing of Flammable Liquids

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### INTRODUCTION:

In this lesson you will view a slide/tape presentation dealing with what you must do to safely handle and store flammable liquids around the drilling rig. You will see demonstrations of what can happen when these liquids are improperly handled. At the end of this lesson you will be given 5 rules for the storage of flammables and 5 rules for the handling of these flammables on or around the drilling rig.

### LEARNING ACTIVITIES:

1. View the slide/tape showing of "Safe Handling and Storage of Flammables and Combustibles".
2. Attend a lecture/demonstration on gasoline and aerosol can explosions.
3. Become familiar with fire safety checklist and be prepared to use it on a rig inspection.
4. In your notes you will list the steps for storage and handling of flammables and combustible liquids.
5. Read and study the student reference section and prepare 2 questions for class discussion.

### STUDENT REFERENCE:

Flammable liquids can be extremely dangerous. For instance, five gallons of gasoline can explode with as much force as 415 pounds of dynamite-a good reason for treating any amount of any flammable liquid with extreme caution! Small quantities of flammable liquids should be stored in their original containers or in approved safety cans. Safety cans have self-closing caps to guard against accidental spills and a pressure-relief vent to prevent excessive vapor pressure from building up inside the can. A special flame arrester is used on all safety container openings. It limits the influx of vapor-forming air into the container, and prevents vapors inside the can from igniting. Even when vapors at the spout are ignited, the flame arresters prevent heat from igniting explosive vapors inside the can. Dispensing drums can also be equipped with

STUDENT REFERENCE (continued):

a special self-closing faucet, and a pressure-vacuum relief vent.

A ground wire prevents the discharge of sparks from static electricity that may accumulate when liquids are transferred from one container to another. Paint acts as an insulator, so be sure it is scraped away before you connect the ground wire clamps. Always connect the ground wire to a suitable ground, such as a water pipe.

Lubricating oil is often stored in a compartmentalized tank, or lubster. Both the inlet and outlet opening of each compartment should be marked to prevent confusion. Self-closing faucets and fire baffles should also be provided. All lubsters, fuel storage tanks, or any large stock of flammable liquids, should be stored well away from the derrick.

It's good practice to use only approved storage cabinets or rooms when storing small amounts of flammable liquids. They are designed to provide the proper amount of ventilation and are able to contain an accidental fire for a specified length of time.

Wherever flammable liquids are stored, aisles and access ways should be kept clear. This allows the material to be handled easily and safely, while providing access for fire-fighting crews and equipment, should they be needed.

The likelihood of fire is increased when flammable liquids are handled. Never handle a flammable substance near a heat source or bring a heat source near a flammable substance. Remember, it is the vapor and not the liquid that is easily ignited. Vapor is not readily detected, mainly because flammable vapor looks like-a clear, colorless gas. Flammable vapor is also heavier than air, so it always sinks to the lowest possible level. It can even flow down stairs or air ducts, thus creating fire hazards far removed from the original source.

Safe transfers of flammable liquids are made in an open, well-ventilated area where the vapors will be diluted and dissipated by large quantities of fresh air. Using funnels and spouted cans makes for quicker jobs and helps prevent spills. When that inevitable spill happens, it should be cleaned up immediately. If there is more spillage than rags can absorb, use water to dilute and flush the spill to a safe area.

Rags saturated with flammable liquids are highly susceptible to spontaneous combustion and must be disposed of properly. Deposit them only in containers provided for them. Never leave them lying around in piles or in unventilated areas.

When refueling or lubricating machinery, be certain that it is shut down first. Pieces of machinery like exhaust pipes and bearings, radiate heat, and electrical systems generate sparks, both can ignite an accidental spill. Always exercise caution when starting up the rig engines, especially after rigging up or engine repairs. Fuel line leaks are apt to be present then, and you must check for them carefully. Be certain that all the fuel supply is shut off by a valve when the engine is not in use.

Paints, solvents, glues, and thinners are often flammable and must be stored in a flame-resistant, well-ventilated storage area. Never use gasoline as a solvent-it produces dangerous amounts of vapor. Always use a low flash-point solvent or thinner for cleaning off paint, grease, or oil around the rig.

When painting, it's a good idea to use older or already opened paint stock first, and to tightly reseal all cans or buckets whenever they are not in use. Painting must be done in a well-ventilated area, away from any prominent heat source. Doing the job outdoors is best, but if you must paint indoors, be sure to provide for adequate ventilation by opening windows and doors, or by using an exhaust fan. Avoid overexposure to paint fumes, which can be toxic or poisonous as well a flammable. Inhalation of paint fumes may cause dizziness or drowsiness. Usually, the best cure is a large dose of fresh air.

Spray painting requires unique safety practices because it produces large amounts of vapor. This vapor can drift to or settle in other areas a good distance from the actual spraying operations, so keep all heat sources well away. Aerosol spray cans are really small spray guns. They almost always contain flammable ingredients that can produce an easily ignited spray. Because of their convenient size, aerosol cans are often stored or set down in unsafe places. Keep in mind that all aerosol cans are pressurized, and that this pressure increases when exposed to heat. If the can is overheated, it will explode.

## 5 Rules for the Storage of Flammables

1. Use a safety can or safety equipped drum.
2. Locate stocks away from heat sources.
3. Store in approved safety cabinets.
4. Keep aisles and access ways clear.
5. Close or reseal all containers.

## 5 Rules for Handling of Flammables Around the Drilling Rig

1. Use spouted cans, funnels, or special pumps.
2. Clean up all spills immediately.
3. Shut down machinery before lubricating or refueling.
4. Paints, solvents, glues, and aerosol sprays are both flammable and toxic.
5. Keep heat sources away.

## EVALUATION:

Answer the following questions in writing:

1. What is a flame arrester or fire baffle?
2. What is a pressure/vacuum relief vent?
3. Why should you use a static electricity ground wire?
4. How should oil soaked rags be stored?
5. Why are oil soaked rags dangerous?
6. Why is it necessary to shut off an engine before refueling or lubricating?
7. How should aerosol sprays be treated and used?

II. DUTY: First Aid & Safety

TASK 25: Proper Handling and Storage of Compressed Gases

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## INTRODUCTION:

In this lesson you will learn the safe ways to handle and store the many different types of compressed gases used on or around a drilling rig.

## LEARNING ACTIVITIES:

1. Attend the slide/tape showing of "Safe Handling and Storage of Flammables and Combustibles".
2. Take part in the discussion on the do's and don'ts when handling or storing gas cylinders, using regulators.
3. You will install a regulator and safely properly check for leaks.
4. You will develop a list, in your notes, on compressed gas cylinder storage and gas handling.

## STUDENT REFERENCE:

Many of the gases you'll be working with are dangerous: some are explosive, others may accelerate combustion, and still others are both flammable and toxic. All gases must be stored under pressure in some type of metal cylinder. This pressure may exert as much as 2,000 pounds per square inch, or psi, on the cylinder walls. If ruptured, a pressurized cylinder may take off like a missile or explode like a bomb; so handle all bottled gases gingerly. Rough handling, knocks, or falls can cause parts to fail.

A dolly is used to move cylinders around the work site. Cylinders should always be transported in an upright position.

Before using any cylinder, be absolutely certain that you know what gas is inside. Tags, stencils, or labels affixed to the product must be checked; they often contain valuable information on the contents and on suggested safe handling procedures. Do not attempt to identify the contents by the shape or color of the cylinder; these features are part of a manufacturer's code and vary widely between suppliers and distributors.

Regulators are used to control the amount of gas leaving the cylinder. A proper fit between a regulator and a cylinder is essential. Regulator threads are specially designed to mate only with the cylinder valve threads on the cylinder of a compatible gas. A properly matched regulator should thread easily onto the cylinder valve; you should never have to apply excessive force or use an adapter.

Regulators must also be kept clean. Grease and oil must be kept away from an oxygen regulator. Oil and oxygen can generate spontaneous combustion. Before installing the regulator, open and close the cylinder valve quickly to clear it of any dust or dirt that might have accumulated during storage. Be sure the opening is facing away from personnel and from heat sources. Using the special cylinder wrench ensures a quick and safe job of installing the regulator. Remember, if it doesn't fit right, it's probably the wrong type of regulator.

If a leak develps for any reason, shut off the flow of gas at the cylinder valve before making any repairs or adjustments. To pinpoint a leak in any part of the system--whether in hoses, valves, or connections--use soapy water or an approved leak detector. Clear the system of gas before making the necessary repairs. Should the cylinder or cylinder valve be leaking, do not attmept to repair it. This is a job for experts only. Move the cylinder to a safe, open area, discharge its contents, and mark it "defective" before returning it to the supplier.

Cylinders should always be secured by a strong rope or chain when gas is being withdrawn. Be certain that all safety devices are in good working order. After its gas is expended, the cylinder must be prepared for a safe return to the supplier. First, close the cylinder valve. Next, remove te regulator and store it in a clean, safe place. Replace the valve cap to protect the cylinder valve from damage during storage and handling. Mark the cylinder empty, or "MT" for short and place it upright in a separate stack for empty cylinders. Never attempt to refill an empty cylinder. This job is conducted by experts at your local gas supply company.

Whether in storage or in use, gas cylinders and tanks must be protected from abrasion and electrical currents, and, or course, all flammable gases, compressed air, and oxygen must be kept away from any source of heat. Because of their unusual properties, the safe indoor storage of compressed gases can be difficult. Check federal guidelines or talk to your gas supply representative before storing any gases indoors. Cylinders stored outside must be protected

STUDENT REFERENCE (continued):

from heat, abrasion, and weather. Store them upright, off the ground, under cover, and away from loading areas.

Federal regulations-and common sense-call for the proper identification of all flammable containers and storage areas.

Many different types of signs are used to indicate what type of danger is present. Caution signs, yellow with black letters on a black background, alert you of potential hazards of unsafe practices. Danger sign, red with white letters ona a black background, indicate that an immediate hazard exists. All signs should be made of durable materials and clearly visible. Report any problems concerning safety signs on your rig to your supervisor or safety engineer. Remember that when you ignore a warning sign, you put your life on the line!

EVALUATION:

Label the following statements with S for safe practice or X for unsafe practice.

__ 1. Handling all gas cylinders carefully.

__ 2. Transporting gas cylinders in an upright position.

__ 3. Securing gas cylinders around the work site.

__ 4. Rolling cylinders around the work site.

__ 5. Using a universal adapter to connect an oxygen regulator to an acetylene tank.

__ 6. Using oil to lubricate the fittings on an oxygen regulator will cause what to happen?

__ 7. Turning the gas off with the cylinder valve before checking for a leak in the system.

__ 8. Checking for a gas leak with soapy water.

__ 9. Replacing the valve cap after removing the regulator.

__10. Keeping empty cylinders in a separate stack.

__11. Refilling a cylinder at the job site.

__12. Using copressed oxygen near a heat source.

EVALUATION (continued):

__13. Storing gas cylinders outside.

__14. Protecting gas cylinders from the weather.

__15. Running a high-voltage electrical line over the gas-cylinder storage area.

Answer the following questions in writing:

What colors are used for caution signs?

Give the colors used for danger signs.

## II. DUTY: First Aid & Safety

### TASK 26: Operate Safely During Well Drilling and Workover

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**INTRODUCTION:**

In this lesson you will learn the different things which you will be expected to do in order to be safe, prevent injuries and avoid accidents during well drilling and workover operations.

**LEARNING ACTIVITIES:**

1. Students will attend the showing of a slide presentation "Safe Practices in Well Drilling and Workover" followed by class discussion and and questions.

2. Read the student reference and list 2 questions for class discussion.

**STUDENT REFERENCE:**

To operate safely on a rig all workers first should have the proper training for their job. Everyone should know how to perform their duties not only properly but safely.

A complete and fully equipped first aid kit should be on the location at all times. At least one person on each rig should have training in first aid and an emergency phone number should be readily available.

You should remain alert at all times and keep your mind on your job. Use all protective devices such as head, eye, ear, hand, and foot gear.

Be sure that all electrical systems are properly protectd. No one that is untrained in electricity should attempt any repairs on electrical systems.

Fire extinguishers should be in good condition, well maintained, and properly located.

STUDENT REFERENCE (continued):

Be aware of all safety signs and heed their warnings for your protection.

Keep your hands out of pinch-points and be sure that all equipment on the rig is safely installed and maintained.

Do not use wire rope that has wickers, has been bird-caged or crushed.

Put all tools and other items, such as slings back in their proper places.

Use all hand tools properly and be sure they are safe.

Rotary hose should be snubbed at both ends to prevent whipping.

Special care should be exercised during perforating, fracturing, cementing, or acidizing of the well to prevent injury.

EVALUATION:

Answer the following questions in writing.

1. Name the steps to be taken during well drilling and workover in order to insure an accident free shift.
2. How can you protect your hands?
3. List three signs that might be on or around a rig for your protection and safety.

## II. DUTY: First Aid & Safety

### TASK 27: Use Tongs Safely

### INTRODUCTION:

In this lesson you will discover the safe use of and the main components of tongs.

### LEARNING ACTIVITIES:

1. View the slide presentation "The Safe Use of Drill Pipe Tongs."
2. Review the chart on the correct installation of tongs.
3. Read, study and prepare 3 questions in writing about anything you don't understand about the student reference material.

### STUDENT REFERENCE:

Tongs are hung with a wire rope called the counterbalance line or tong-hanger line. Connected to the tong hanger, the line runs upward through sheaves attached to the derrick and back down to a weight called a counterbalance. The counterbalance should weigh the same as the tongs. The hanger line should be properly attached to the tong hanger. The line is looped through a clevis on top of the tong hanger. Two wire-rope clips are used to secure the loop. The sheaves the hanger line runs through should be well secured to the derrick. The sheaves should be pinned, bolted, or hobbled to the derrick with good wire rope.

There are several ways to counterbalance the tongs. A short piece of casing, closed at bottom, has iron placed inside to equal the tong's weight. This method should only be used if the counterbalance is below the derrick floor and away from personnel. The counterweight could be a short piece of casing with a valve at the bottom and weight is regulated by adding or removing water. Never to try to counterbalance the tongs by hanging or tying weights on them. Instead, if the counterweight is too heavy, take some of the weight out of it or if two counterweights are being used, maybe only one is needed.

The snub line keeps the backup tongs from turning as torque is applied to the lead tongs to break out or make up a joint of pipe. It is very important to install a snub line correctly. The snub line should be just long enough so that the angle made by the tong body and line is 90 degrees.

A good way of attaching the snub line to the tong arm is to put a clevis through an eye in the line and then bolt and pin the clevis to the arm. Wire-rope clips can also be used to make an eye. The other end of the snub line-the anchor end-should be secured to a backup post that is bolted or pinned to the rig structure. Be sure the line doesn't wear against a sharp corner of the structure so it won't be damaged and broken.

Good wire rope of the proper size for the expected loads should be used for the snub lines. The safe load in pounds for new improved plow-steel rope, consisting of six strands of 19 wires each, with a hemp center, depends on the diameter of the rope. For instance, quarter-inch rope can safely handle an eleven-hundred pound load. Of course, as rope diameter increases, safe load also increases. Minimum diameter recommended by IADC for tong snub lines is 5/8-inch, which can safely handle a 6,600-pound load.

If you use wire-rope clips on snub lines, there are a number of things to keep in mind to install them correctly. First, always turn back the correct amount of rope and use the proper number of clips. The amount to turn back and the number of clips to use depends on the diameter of the wire rope. Charts are available that show the rope size, the minimum number of clips, and the amount of rope to turn back. For example, with 5/8-inch rope, at least three clips should be used with 12 inches of turnback. 12 inches of turnback is secured with 3 clips. One clip is close to the end of the turnback, another is close to the base of the eye, and the third clip is evenly spaced between the other two--this is the correct way to place clips. There's only one way to attach wire-rope clips. The U part of the clip goes over the dead end of the line.

If you have to cut a piece of wire rope to make a snub line, be sure to put fric-tion tape on either side of the cut to keep the rope from unraveling. Always wear goggles to protect your eyes from flying wires that may come loose as the cut is made.

Once the snub lines are attached, adjust the tongs to hand level. The adjusting nut at the top of the tong hanger and the adjusting nut at the base of the hanger allow you to hang the tongs level with the rig floor.

As for tong maintenance, first of all keep them clean. Clean tongs are easier to operate and they last longer. After the tongs are cleaned, they should be greased. There are grease fittings on each moving part of your tongs. Grease the tongs at every tower change and before and after each trip. Also, grease them only after you clean them, so the grease won't get washed off. The tong pins and latch springs should be oiled frequently. Keeping them oiled makes the tongs very easy to latch and unlatch. Grease the sheaves that hold the tong-hanger line in the derrick. Tong dies are serrated pieces of very hard steel that are mounted inside the tong jaws. They are used to ensure a good grip on the pipe when the jaws are latched. Dies are subject to wear, so they should be inspected regularly and checked for wear. If they are worn, replace them. To replace dies, you'll need a special diedriving tool and a hammer. Be sure to wear goggles because dies are made of brittle steel and can easily be chipped, sending a flying particle into your eye. The button pin with a keeper prevents the die from sliding up or down and out of the slot in the tong body. Keep the pins in place and in good condition; othewise the dies may fall out. If they should fall into the hole, they'd have to be fished out, which could be expensive. Check the tong heads, jaws, and pins for cracks and wear. Worn pins or heads may cause the tongs to slip off the pipe causing an injury. Also, fatigued latch springs keep the tongs from latching properly, so replace worn springs. Check the snub and pull lines at the beginning of each tower for wear, and check clamps and clips for tightness. A line showing any kind of flaw-broken wires, broken strands, kinks, cracks, and so on-should be replaced immediately.

Good footing around the rotary is a must if the tongs are to be operated properly and safely. Roofing material provides a nonskid surface; cocoa mats or other abrasive materials can also provide good footing.

When actually using the tongs, there are several pointers to keep in mind. Always use tong handles, the only time your hands should be on the latch handles is when the tongs are being latched or unlatched. When manipulating the tongs, keep both feet firmly on the rig floor. If you're off balance on one foot, and something unforeseen happens, you may not be able to get out of the way.

Be sure the tong heads are the right size for the pipe being used. When pulling pipe out of the hole, or when breaking out the kelly, be sure to latch the lead tongs above the break where the shoulders of the pin and box of the pipe meet. With the lead tongs above the break, there's no danger of the tongs biting into the pin or box, which could cause the tongs to fail or a line to part and a serious injury when the driller starts the rotary to back out the connection.

Drill collars must be tightened much more than drill pipe and are much harder to break out. So, it's best to make the tongs bite and then move completely away when drill-collar connections are being made up or broken out. The possibility of the tong lines breaking or the tongs slipping or breaking are greatest at this time.

STUDENT REFERENCE (continued):

When picking up pipe or going in the hole, a crushing accident can sometimes occur as the pipe is being led in or tailed in toward the rotary.

Never turn your back on a stand being moved. The stand could get away from the crewmen moving the pipe, smash into your back, and shove you right into the tongs, causing serious injury. Also, always be on guard to keep your fingers and hands from being mashed against the tongs.

When an inexperienced person or "weevil" starts out, the chance of tong accidents is multiplied. But good training cuts down on the chances of injury. Explain to the new person what to expect from the equipment, what you expect out of him, and the hazards involved. Let him look at the operation and then try it himself. Do this with understanding and patience and you'll help mold a good, safe employee.

If you notice an improper installation on your rig-like an improperly attached tong snub line, tripping hazards, or whatever, either correct the problem or report it to your supervisor. But at the same time do your part for safe tong operation. Maintain your tongs, install them properly, operate them safely, and the life you save will be your own. Safety is everyone's business.

EVALUATION:

Answer the following questions in writing.

1. Using the chart on the correct installation of tongs, name the parts indicated.
2. List 5 things you need to do to operate the tongs in a safe manner.
3. The tong-hanger line is also called the _________?
4. When the snub line is pulled tight the angle between the line and tong body should be ___ degrees.
5. What is the correct position for the U-clips when making a turn back on a wire rope.
6. If you have trouble getting the tongs to latch properly what might be the problem?
7. Should the latch handles be used to make the tongs bite?
8. What should you do if you notice an improper installation on the rig?

## II. DUTY: First Aid & Safety

### TASK 28: Use and Care of Basic Tools

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### INTRODUCTION:

In this lesson you will be given very basic information regarding treatment of tools, their use and care. The lesson will stress do's a and don'ts for the safety of the individuals and protection of tools.

### LEARNING ACTIIVTIES:

1. Attend the showing of the slide/tape presentation "Use and Care of Basic Tools".
2. Develop a list of safety tips for the use and care of basic hand tools.
3. List 2 questions on student reference material you do not understand.

### STUDENT REFERENCE:

A screwdriver is intended for one thing -- to loosen or tighten screws. But a lot of people use it for so many other things that it's one of the most misused tools in the kit. It's definitely not a pinch bar. Using a screwdriver to pry things open can end up in a broken or chipped blade or shank. Another thing you don't want to do is hammer on a screwdriver. It's not a punch or a chisel. You always want to be sure to use the right size screwdriver. The thickness of the blade should make a good fit in the screw slot. This will keep you from burring the screw slot. Also, it's easier to turn the screw. Another thing -- keep both your hands behind the screwdriver when you're putting pressure on the screw. If the blade slips off the screw and your hand is nearby, you could easily stab your hand. A heavy-duty screwdriver has a square shank. It's made that way so you can use a wrench on it to loosen up stubborn screws. Never use pliers on a screwdriver. The pliers are just going to slip, and you will not only damage the shank, but you will probably burr the screw slot as well.

Hammers are another tool we use a lot. There are many different types, but we'll use the ball peen hammers for our discussion.

STUDENT REFERENCE (continued):

Simple as a hammer is, there are right and wrong ways to use it. For one thing, always grab the handle close to the end. This way, you can hit a good, heavy blow. Don't choke up on the handle. Always try to hit the object with the full face of the hammer. In other words, strike the object so that the face of the hammer and the surface of the object are parallel. Here is the wrong way to do it. The top of the head is hitting the work first. The head of the hammer should always be tight on the handle. Never use a hammer that is loose. If the handle is loose, use a wedge to expand the handle in the head. The wedge keeps the handle and head tight together. Never use the side of the hammer head to hit or drive anything. Finally, don't use the handle to drive or pry anything. You'll probably break the handle.

Combination pliers are supposed to be used for holding pipes or for bending metal stock. Don't use pliers to loosen or tighten nuts. If you do, you'll wind up rounding the corners on the nut. Always use a propersized wrench. In fact, it's a good idea not to use pliers whenever any other tool will do the job. Diagonal cutting pliers - called diagonals, or sometimes dikes - are good for many cutting jobs. Long-nosed and side-cutting pliers also come in handy. Side-cutters are the best for cutting wire. Whatever pliers you use should be the right size for the work. For example, if you're cutting wire, get a side-cutter big enough so you can make the cut with one hand. Pliers, like all your tools, need to be kept clean. Also, from time to time, it's a good idea to oil the joint. If you do this, you'll cut down on wear and prevent rust - a vicious enemy to all tools.

There are a few simple rules for the correct use of open-end wrenches. The first rule is - be sure that the wrench fits the nut or bolt head exactly. Nothing burrs a nut or busts your knuckles faster than the wrong size wrench. When you have to put a hard pull on a wrench, make sure the wrench seats squarely on all sides of the nut. Always pull on a wrench - don't push. Pushing on a wrench is dangerous. When you push on a wrench to loosen a nut and the nut suddenly breaks loose, you'll probably hit your knuckles or some part you overlooked and knock off some hide.

Adjustable wrenches - usually called Crescent wrenches after the brand name - have a few rules you need to know. Crescent wrenches are most often used when you find an odd-size nut or bolt head that one of your wrenches or sockets won't fit. Crescent wrenches aren't made to take the place of open-end, box-end, or socket wrenches. Adjustable wrenches aren't intended for hard service, so treat them a little gently. When you want to loosen or tighten a nut with a Crescent wrench, there are two rules you need to follow.

STUDENT REFERENCE (continued):

First, always put the wrench on the nut so that the pulling force is on the nonmoving side of the jaw. Second, after you put the wrench on the nut, tighten the adjusting knurl so the wrench fits the nut snugly.

Pipe wrenches are another adjustable wrench you'll see a lot of. You'll use them to tighten and loosen pipe and fittings. The best way to use a pipe wrench is to put the wrench on the pipe so that it's about in the center of the wrench jaws. In other words, leave a gap between the pipe and the back of the wrench. The jaws of the wrench bite down on the pipe when you pull down. When you lift up on the wrench, the jaws lose their bite. So, you get a kind of ratcheting action when you use them properly. Don't use the wrench to bend or lift pipe. Never hammer on a pipe wrench. Sooner or later, you'll break the wrench or injure someone.

Don't use a hacksaw to cut pipe. Always use pipe cutters.

A pipe threader is used to put outside threads on the end of pipe. They're placed on the end you want to thread. When you rotate the tool, it cuts threads into the pipe.

Box-end wrenches are very popular. An advantage of this type of wrench is that there is less chance of the wrench slipping off the nut. Also, since the sides of the opening are so thin, a box-end wrench is handy for nuts which are hard to get at with an open-end wrench. Besides the regular box wrenches with straight handles, some have heads which are offset at a 15 degree or 45 degree angle to the handle. This means that when the wrench is on the nut, there is a space between the wrench and the work, where you can put your hand. These are real knuckle-savers.

Combination box-end and open-end wrenches are very handy. You can break loose a nut with the box-end, then change to the open-end to take the nut off. This will often speed up the work.

For very heavy-duty work, large box wrenches are made which have an end you strike with a hammer. This is the only type of wrench you should ever hammer on. And, notice too, that you use a hammer big enough to do the job.

Socket wrenches are really a boon to everybody. To use a socket wrench, you first choose the right size socket to fit the nut or bolt head. Then you put it on the ratchet handle and place the socket on the nut. A ratchet handle really lets you work fast. You loosen or tighten the nut in one direction and ratchet back in the other. You don't have to raise the socket off the nut to get another bite. There are many other socket handles besides the ratchet. The flex handle is one. With this handle, you can loosen or tighten nuts where a lot of leverage is needed. You should avoid using cheaters to get leverage. The speed handle is another handy one. You work it like the brace of a woodworker uses to drill holes. Usually, you have to break loose a nut with another handle. But, once the nut is loose, you can put on the speed handle and really move the nut fast. One precaution about using socket wrenches: be sure to use a socket that is hefty enough for the job.

There are a number of things to remember about chisels. Always use a chisel that is big enough for the job. Use a hammer that is heavy enough for the chisel - the larger the chisel, the larger the hammer. Always wear goggles to protect your eyes when you're chipping. Also, if there are other men nearby, see that they have goggles on too. When chipping metal, the depth of the cut is controlled by the angle you hold the chisel at. Don't try to take too deep a cut. For rough cuts, 1/16 inch is enough; half that much, or less, is right for finish cuts. If you're using a chisel on a small piece clamp it in a vise. Chip toward the solid, or stationary, jaw of the vise. Always chip in a direction away from, never toward, yourself. Always make sure that the chisel is sharp and that the head is not upset or mushroomed. If you hammer on a mushroomed chisel, pieces could fly off and hurt someone.

A center punch is a good tool to have handy when you're about to drill holes in a piece of metal. Before you set the drill bit on the piece, use the punch to locate the center of the hole. Then hit the punch with a hammer to make an indentation. That way, the drill bit won't wander around. Don't ever hit or even tap the point of a punch or chisel with a hammer. The steel in the points of these tools is very hard and brittle. A blow will cause it to shatter, and small pieces will go flying off everywhere.

There are many different types of files - from a flat file, a half-round file, or a triangular file, to the round rattail file. Before you use any file, be sure that it has a tight-fitting handle. If you don't use a handle and the file gets hung up on something, you could easily hurt your hand on the sharp end. When you use the file, remember that you file in one direction only - when the file's being pushed forward. When you come back, raise it off the work. Holding pressure on the file on the back stroke will dull it in a hurry. Another thing to remember about files is - use only enough pressure to keep the file cutting. Too much pressure is as bad as too little. When the teeth of the file get clogged up with filings, clean it with a file card. A file card is a brush with short, stiff wire bristles. Never use a file for prying. The body of the file is hard and brittle. Even a light bending force will snap it in two. Also, never hammer on a file - it may shatter and send chips flying in every direction.

A hacksaw is a lot like a file. Like a file, the most important thing to remember with the hacksaw is that you saw in one direction only - when the saw is pushed forward. On the back stroke, ease off on the saw. This way you won't dull the blade so fast. Try to use the entire length of the hacksaw blade on every stroke - except when you're getting the saw started. Keep the blade moving in a straight line to avoid any twisting or binding that might break the blade.

Use the level to level up a piece of equipment. When the equipment is level, the bubble will be centered between the marks. You can also use a level to plumb up equipment - that is, to make sure it's absolutely vertical. When the equipment is plumb, then again the bubble is centered between the marks. Notice that the bubble is in glass. So that means you've got to be a little careful. Take it easy with your level so you don't break the glass.

There are a few safety rules you need to know, which concern all electric tools. The most important thing to remember is that all electric tools should be grounded. To tell you what we mean by grounded, consider this: there are three things which make up an electric shock. First, there is electric current. Second, there has got to be a ground or a connection to ground. (Electricity always wants to run to a ground.) Third, there is you. If you're standing between the electric current and the ground, you're part of the circuit. Thus, the current will run through you to the ground. In other words, you get shocked. So, to avoid a shock, a third wire is used to carry any shorted current to ground before it reaches you. That is why electric tools have three prongs on the plug. Two prongs carry the current, and the third is a safety ground wire to protect you. Even with a three-prong ground, you can still get shocked if you do something foolish ... like bypass the ground wire ... or stand with your feet in a puddle of water. There is no danger, as long as you make sure that the tool is grounded and that you're not a better ground than the ground wire (don't stand in any puddles of water, and don't grab hold of or cut into an outside source of electric current).

You're all familiar with the electric drill. You pull the trigger and drill away. But let's look at a few tips that may make your job even easier. First make sure that the size of the hole you want to drill is within the capacity of the tool. For example, a 1/2-inch drill is made to drill holes up to and including 1/2-inch and no larger. Mark the location of the hole carefully, and start it with a center punch, as we mentioned earlier. Then, with the motor running, put the drill into the punch mark and start drilling. Take care to hold the drill at right angles so the hole will be straight. Exert light pressure and continue drilling until you finish the hole. Use a side handle on large drills. With small pieces, it's a good idea to clamp them in a vise. That way, the piece is held stationary, and you won't cut yourself on a twirling piece of metal.

When using a drill press, you should keep some safety points in mind. On small work, you may have to hold it with a wrench or a clamp to keep it stationary. You can vary the rotating speed of the drill press by changing the drive belt from one part of the pully to another. You would use slower speeds for drilling metal.

Another electric tool that we use is a bench grinder. It's used to sharpen and dress chisels and screwdrivers, for instance. The grinding wheels come in various grits, from smooth to rough. Often, one wheel on the grinder will be smooth, while the other is rough. Or sometimes one side of the grinder will have a wheel and the other, a wire brush. The work rest on a grinder should be no more than 1/8-inch from the wheel. Another thing, for sure - whenever you're using a grinder or brush, always wear goggles. The goggles will protect your eyes from any flying chips of metal.

To summarize the safety points covered, remember the following:

-Watch out for loose-fitting clothes; for example, loose sleeves on long-sleeved shirts. The sleeves could easily get bound up in some part of a tool. For this same reason, it is not a good idea to wear jewelry to work.

-Always wear safety goggles when you're grinding, chipping, or scaling.

-Make sure all electrical tools are grounded.

-Unplug electrical tools whenever they're not being used.

-When you're through working in an area, clean it up. Practice good housekeeping.

-Put tools back where they belong.

-Keep all your tools cleaned and oiled.

-Always use the right tool for the job.

-Keep tool guards in place on all power tools.

-On grinder wheels, always check the wheels for cracks before and after you use them.

STUDENT REFERENCE (continued):

-Match the speed of the grinder with the speed for which the wheel was made.

-When you're drilling, be careful not to drill through the work and into yourself or somebody else. Drill the work, not a person.

-One more very important thing - most electrical tools aren't sparkproof. So you always make sure you use them in a safe area. An electrical spark from starting up the tool will set off an explosion in an area where gas exists. Also, sparks from grinding and chipping will do the same. So take care; these operations could be as dangerous as welding.

EVALUATION:

Answer the following questions in writing:

1. Shown a variety of hand tools you will identify the tool and state the do's and don'ts for its use.
2. Why should a chisel not be mushroomed and what should you do if it is?
3. Why should you check grinder wheels?
4. Give the reason for grounding electrical tools.
5. Why should you be careful of sparks?
6. Give 2 safety practices to be remembered when using an electric drill.

## II. DUTY: First Aid & Safety

### Task 29: Learn the Treatment for Snakebite

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**INTRODUCTION:**

In this lesson you will learn to identify a poisonous snakebite and the first aid for a poisonous bite.

**LEARNING ACTIVITIES:**

1. View slides on pictures of the different types of poisonous and non-poisonous snakes that might be found in this area.
2. Learn the different features of nonvenomous and venomous snakes.
3. Learn the pattern of the bite of the nonvenomous and venomous snakes by viewing slides, on sketches which will be given out in class.

**STUDENT REFERENCE:**

Few creatures are as universally feared as poisonous serpents, but the fact is that snakebite is a far cry from the "certain death" that many people consider it to be. To begin with, the chances of being bitten by any-snake venomous or not-are slim.

Unfortunately, the only available statistics on the effects of venomous snakebite are nearly 20 years old and thus outdated, but if the ratio recorded then still holds true, only one bite in 3,000 is likely to be fatal, while some 10% to 20% produce no effect whatsoever, even if the snake's fangs do penetrate the skin! Fatalities occur most often when elderly people, idividuals who are ill, or small children are bitten...or when a person who is struck receives no treatment. Authorities estimate that-in the U.S.-there are no more than 12 to 15 deaths from snakebites per year at present.

The best way to deal with snakebite is of course, to avoid getting bitten in the first place. And perhaps the best way to do that is to know the various serpents and recognize their preferred habitats.

STUDENT REFERENCE (continued):

Of the four venoumous snake types in the U.S., three-the various water moccasins, copperheads, and rattlesnakes-are pit vipers and share some common characteristics. All have (a) a pit-or hole-between the eye and nostril, which is heat-sensitive and helps the snake locate prey (these reptiles are also very responsive to vibrations, but can't actually "hear"), (b) vertical pupils in their eyes, ;(c) wedge-shaped heads that are wider than their necks, and (d) hinged poison fangs that lie flat against the roof of the mouth when the jaws are closed, then snap forward and erect when the mouth is opened. In addition, all three have a venom that's destructive to blood and tissue and produces symptoms within a few minutes after being injected.

The most common pit viper in the United States, and the poisonous snake responsible for the greatest number of bites, is the rattlesnake. There are approximately 20 species and subspecies of rattlers: Some are light, some dark, some marked with diamonds, while others are blotched or banded...but all may be recognized by the horny string of interlocking, loosely fitted rattles at the end of the tail. When vibrated rapidly, these rattles produce a distinctive buzzing sound, but-contrary to legend-the snake may or may not choose to vibrate its tail when disturbed. Chief among this group of reptiles are the eastern and western diamondbacks, which are large and capable of injecting a sizable amount of poison with one bite.

The copperhead is, by some standards, a rather handsome snake...and the only one in the U.S. whose hourglass markings are positioned with the constricted portion of the design down the midline of its back, as though someone had bent the hourglass across its spine and down on either side. The color can vary from almost pink to dark chestnut brown, with only some specimens having the bright copper-colored head that gives the species its common name.

The cottonmouth, or water moccasin, is a heavy-bodied snake with a reputation for bad temper. It's difficut to identify quickly because its markings tend to become indistinct with age. Besides having the usual pit viper characteristics, the cotonmouth has a broad, dark band extending from the nostril through the eye to the angle of the jaw on either side of the head. The interior of the mouth has a white "cottony" lining that's visible when the snake gapes threateningly at an intruder. Unlike other water snakes, the cottonmouth swims with its head well above the surface, but is can bite just as easily under the water as out of it.

Regardless of which of the four venomous snake types may live in your area, it's important to keep in mind that woods and meadows, or even tumbeldown buildings,

III. DUTY: Site Preparation

## TASK 1: Know How to Operate a Chain Saw Safely

**LEARNING ACTIVITIES:**

1. Chain saws will be examined and the safety features noted.

2. Practice cutting logs and limbs in a safe way with a chain saw.

3. Chain saws will be sharpened properly and used for the performance of Item #2.

4. Safe fueling of the chain saw will be thoroughly discussed in class.

5. A slide presentation on chain saw safety will be presented followed by discussion.

6. Read, study and prepare two questions about the student reference material.

**STUDENT REFERENCE:**

When you arrive at a new site the only thing you will see will be trees, brush, rocks, logs and lots of natural accumulation. Before any equipment will be able to move in the area, it will need to be cleared and one of the main tools you will use will be the chain saw.

Chain saws have been around for about 50 years. In the old days they were big, clumsy and dangerous; now they are lightweight, handy and still dangerous. Many advances and safety features have been made but a chain saw is still not a toy; operating a chain saw safely takes knowledge and skill.

The main hazard of a chain saw is from that fast moving chain. Kickback, and upward jump or jerk of the saw is one way you can get caught by the chain. Kickback is caused by striking a limb with the tip of the moving chain, running the engine too slowly at the start or during the cut, a dull or loose chain, cutting above shoulder height, or a loose grip.

The loud engine noise can damage hearing and there is the danger of fire from a gasoline powered saw, or shock from one with electric power. You can cut yourself on the sharp saw teeth even when the chain is stopped. You could fall while carrying or operating the saw, strain or sprain your back, or arms, or burn yourself on hot engine parts.

STUDENT REFERENCE (continued):

The chain saw will be either electric or gasoline powered, and can range in size from under ten pounds to a hefty 25 pounds or more. Use the correct size for a specific job. A small lightweight saw is ok for cutting firewood but not for felling a huge tree in the forest.

The first step in chain saw safety is to study the operating manual provided by the manufacturer. Be sure you know and understand all operating instructions. Know how to start the saw and kow what kind of adjustments you will have to make and when you will have to make them; always keep the manual handy for reference.

The trigger throttle, hand hold, chain brake, and oiler button, are all safety features. These features can not do you a lot of good unless you know where they are and how to use them.

What you wear when you operate a chain saw can make a big difference in how safe you will be. Avoid loose clothing, jewelry or dangling items that might catch in the saw. Do wear clothing that fits well, no loose sleeves, cuffs or scraves.

Be sure to wear the right protective equipment. Safety shoes are recommended and a hard hat, you need gloves to protect your hands and eye protection against chips and dust. Chain saws are loud so ear plugs or muffs should be used if there is long exposure to noise.

When you are fueling a chain saw the first rule is no smoking or fires allowed. Clear the fueling area and do not start fueling unless the saw is cooled. Always store and carry gasoline in a safety can. If gasoline is spilled, be sure to wipe it up at once. Be sure to follow the fueling procedure in the operator's manual carefully. For safety never start the engine at the fueling location and keep a fire extinguisher handy. It is always best to use a spark arrestor on the saw.

Carrying a saw can be dangerous if you do not obscure certain precautions. Never carry a saw with the chain in motion. Stop the engine if you are moving any distance, never carry a saw over your shoulder. Always carry a saw with the blade to the rear with the hot muffler away from your body.

If you transport your saw in a truck be sure the saw is cool, put it in a rack or block it so it can not move. Always use a bar guard and be sure the fuel cap is on tight to prevent spills.

Before you start to use a chain saw, clear your working area. Get rid of any brush or growth that could keep you from having good footing. Always be sure that no limbs or

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wires will interfere with the operation of the saw. You should check the ground carefully for holes and other tripping hazards.

The real danger starts when you start the saw so be sure you follow the manufacturer's instructions carefully. Before you begin, always check the chain for the correct tension and be sure your footing is good and solid. Place the saw on level ground, hold the saw firmly by the handle and start the engine as the manual instructs. Once the saw is started let it run long enough to warm up before you use it.

Never drop start a chain saw, you could be injured if the saw swings or turns and comes in contact with your body. This method of starting is also hard on the equipment.

When operating your chain, saw watch out for other people, keep out of the path of the tree you are felling as well as, out of your operating area. Flying chips are dangerous enough but what if your chain breaks, fragments from a broken chain can cause serious injury to anyone they hit. The safe thing to do is to stop the the saw if anyone comes into the operating area.

A tree or pole you are felling could snap or a limb or cross arm could suddenly fall, so be ready to escape if you need to. Before you start a cut be sure you have an unobstructed way to make an emergency escape. Clear away any brush and look for tripping hazards.

When you fell a standing tree or pole always make an undercut to control the direction of the fall. Line up the first undercut carefully to face that direction. Begin by cutting into the tree 1/3 of its diameter to assure full control of the tree when it falls. The height of the second cut should be 45° in relation to the first cut to take out a wedge.

Make the back cut, on the felling cut, 2 inches above the undercut so the tree will not kick back when falling. Make this cut straight and horizontal and leave a hinge of wood so the tree will not spin off the stump when it falls.

Always hold the saw with both hands and never cut over your head or reaching out at arms length. Before starting a cut be sure the controls are functioning properly and keep plenty of oil on the chain, keep the chain tension tight and adjust it if it should loosen.

When you remove limbs from a felled tree, stand on the opposite side of the trunk from the limb you are cutting if you can. The most important thing to remember is to work on the up hillside and be sure you have good footing. Do not cut limbs that are propping up the log. Do your cutting from the bottom side of the limb because the saw is less likely to bind than if you would cut in the crouch.

STUDENT REFERENCE (continued):

Bucking or cutting the trunk of a felled tree into sections requires some precautions to remain safe, first you should clear the work area of brush, block the tree so it will not roll, and work on the up hillside. Plan the cut so the log drop will open the cut and keep the saw from binding. Just before the cut is completed, slow the motor. and hold it away from your body.

If the log is in a bad position, cutting it can be very dangerous. If necessary move the log to a safer position before you start working on it. Never remove supporting limbs until the log is bucked into lengths, use them to keep the log off the ground.

If the log is resting on the ground, you should overbuck or cut from the top. Be sure you do not let the saw touch the ground when cutting in this manner.

If the log is supported at one end overbuck 1/3 of its diameter and then overbuck the second cut to prevent binding.

If the log is suppored at both ends, overbuck 1/3 of its diameter and finish the cut with an underbuck.

Never carry a saw with you into a tree. It's best to raise and lower the saw by a rope. Start the engine only after you are well braces in the tree and ready to cut. Always stop the saw before lowering it to the ground. Be alert for any electrical wires. Do not try to reach too far to avoid any strains and falls.

Take good care of our saw and it will be safer. Inspect your saw regularly, keep the chain adjusted so it will stop when the engine is at idol. Be sure to keep the chain sharp. A sharp chain will cut faster, easier, and thus safer.

Keep the air filter and cooling fins clean and free of oil, gasoline and saw dust.

If you have an electric saw, inspect the power cord and make any repairs necessary.

If you sharpen your chain, be sure to follow the manufacturer's instructions very carefully. When performing this operation, wear protective gear such as eye protection and gloves. It is best not to sharpen the chain in the field, but instead carry extra chains with you.

Never hold filters or parts in your hands when you clean them with compressed air and wear eye and face protection for protection from blowing dust. Keep other people away when using compressed air. Never use compressed air to clean your own body or clothing.

## STUDENT REFERENCE (continued):

First aid can keep a bad injury from becoming worse. All injuries, including cuts and scratches should be reported and treated. Every field crew should have a first aid kit that is equipped to care for the kind of injuries that are likely to happen. At least one member of the crew should be trained in first aid.

Chain saws can be dangerous, but if you follow safe procedures, you can prevent injuries to yourself and others. Remember --- you are the only one that can insure safe operations of your saw.

Remember these points:

1. Know your saw and always use the right saw for the job.
2. Know what might go wrong, it's the best way to guard against trouble.
3. Wear protective equipment such as hard hats, gloves, shoes, face shields, and ear protection.
4. Stay alert and do not take chances, your chain saw will be as safe as you make it.

## EVALUATION:

Answer the following questions is writing.

1. What is kick back and what can cause it?
2. Name at least five hazards to be aware of when using a chain saw.
3. What is the first step in operating a chain saw safely?
4. List the safety features you will find on a chain saw.
5. Describe what you will wear when operating a chain saw to be safe.
6. Give the safety rules to be followed when fueling a chain saw.
7. Tell how to be safe while carrying a chain saw.
8. Give the safety precautions you would observe while operating a chain saw.
9. Give the different methods of making buckcuts.
10. What safety rules should be followed when working up in a tree?

IV. DUTY: Drilling Operations

TASK 1: Making Hole

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## INTRODUCTION:

This lesson will be concerned primarily with how the rig is used to make hole in such a way that the contractor makes money. You will be taught the many possibilities for good performance and the disaster that can result from poor drilling.

## LEARNING ACTIVITIES:

1. Each section of this lesson will be read and discussed individually. Illustrations, pictures, and charts will be shown and explained by the instructor.
2. Attend a lecture/discussion by a consultant from a local drilling company. Take part in a class question and answer session.
3. Read student reference section and write down 3 questions about the material which you don't understand.

## STUDENT REFERENCE:

It is not often that everything can be ideal in drilling. Decisions on the proper course in making hole involve many compromises. Let us illustrate with only one example:

A certain section to be drilled is for the most part easy digging - soft shales for example. So a long-tooth bit is run in. In the soft digging there turns up one thin section of hard rock. You dull the bit and pull it before you break out of the hard streak. You decide to run in a hard-formation bit. You drill a few feet and break out into the soft, sticky shale again. Your hard-formation bit just will not cut it. So you pull it. Now, what to do? Could be that you compromise on a bit that will make hole in the soft stuff - though not as fast as you might like. But it will also stay with you longer if you hit another hard stringer. This is a compromise bit that is less than ideal in either the soft digging or the hard.

## STUDENT REFERENCE (continued):

The business of making hole is often a long series of such compromises. To make the right decision the driller and pusher have to be aware of the factors involved in drilling. The most significant of these will be mentioned here and discussed further along.

1. The geological section. This refers to the nature of the formation to be drilled.
2. The capability of the rig.
3. The drilling fluid program.
4. The bit.
5. Three critical factors:
    - Weight on the bit
    - Rotary operation
    - The hydraulic factor

## THE GEOLOGICAL SECTION

### Formation Fluids and Pressures

One of the first things which should be on the mind of the driller is what underground pressures of gas and/or water flows which have been recorded in the area. If these may prove to be critical, at what depth are they likely to occur? Is it likely that the formations to be penetrated may contain dangerous volumes of water or gas to contend with? If so, what does this suggest as to emergency preventer equipment? What about salt water flows and the maintenance of the drilling mud condition?

### The Crooked Hole Problem

Is the well to be drilled in crooked hole country? If so, at what depth does the trouble first show up? What is the operator's policy with reference to deviation of the well bore? What is written into the contract regarding deviation of the hole, either in respect of total angle built or of maximum deviation in any section of one hundred feet (the "dogleg")?

### Geological Markers

In most areas where extensive drilling has been done there are well-known underground markers by which to correlate the estimates of the "highs" and "lows" to be found deeper in the well.

## Faults

The fault is a geological feature in a great many fields. In fact, the fault quite commonly plays a major role in the accumulation of oil and gas which makes a field. A driller need not be even an amateur geologist in order to comprehend the significant role faulted formation can play in the business of drilling.

Drilling in some faulted fields is characterized by such unusual occurrences as drilling the same formation more than once, picking up a formation higher or lower than expected, and finding some formations that should have been drilled to be missing entirely.

## THE CAPABILITY OF THE RIG

A drilling rig has two capabilities for purpose of our discussion. One might be called the "overall capability" and the other the "holemaking capability".

### Overall Capability

As the title suggests, this section is concerned with the capacity of the rig to do all those things which contribute to getting a well down. Almost everything on the rig has to be considered.

Hoisting capacity is very definitely a part of expeditious round trips as well as handling strings of casing. Adequate braking equipment is an essential part of hoisting. The capacity of the prime movers used in hoisting is a part of the overall picture.

### Holemaking Capability

Suppose a driller comes on the floor. He relieves a crew which has just put a sharp bit on bottom. He lays a hand on the brake. He slacks off and finds bottom. This is a "moment of truth". For the next 8 hours he is face to face with the proposition of making some footage and earning his keep.

He is about to use the full holemaking capability of the rig, at least to the best of his understanding and ability.

## Holemaking Capability (continued):

Until he gets the kelly down he is concerned with:

1. The pumps (and prime movers).
2. The rotary (and prime mover).
3. The drill string and bit.

As soon as he gets the kelly down there will be a short period of time when the holemaking stops. This is to make a connection and get the kelly back up so he can make it down again. So it will go - hopefully - for the rest of the tour:

Make hole - make connection - make hole, etc., etc.

Finally, sooner or later, comes a round trip for a new bit. Holemaking is interrupted again - for a longer period this time. For the duration of the trip the pumps are shut down. The drill string and bit are so much dead weight. Now is when he is concerned with the overall or more especially, the hoisting capability of the rig.

## Rig Requirements for Making Hole

He starts the pump. How much pump?
He slacks off weight. How much weight?
He starts the rotary. How many rpm?
The bit is on bottom. Is bottom where it was supposed to be?
The bit starts to dig. What kind of bit?
The mud starts to circulate. What kind of mud?
The mud level rises or falls. What was the level?

## Requirements for Tripping

When the first connection has to be made, the hoisting apparatus on the rig is put to use. Perhaps there will be a short trip to test the possibility of a blowout - in case the well is acting up. Then comes the main event, the full round trip.

How does the available horsepower measure up against the weight of the string to be pulled?

How many lines are strung up in the blocks?
How much pull will the derrick or mast withstand?
What are the capacity and condition of the brakes?
From the above, how long will the bit be off bottom with the pump shut down?

## Hoisting Requirements

Hoisting time for round trips and connections is non-productive usage of a drilling rig for its main purpose, but this work is essential to change bits, to add pipe as hole is drilled, and to remove the string for logs, etc. The drawworks, blocks, hook, etc., should be sized for the work and powered by engines suitable for the job, thus to minimize time off bottom.

## Rules of Thumb

The actual horsepower requirements for drilling cannot be determined with extreme accuracy, simply because there are too many variables from one well to another, or from one depth to another.

Many experienced men in the field have come up with rules of the thumb which serve a very good purpose. These rules are estimates based on past experience. The fact that they continue to exist in the lore of drilling is testimony to their usefulness. Some common ones:

1. For hoisting: We need 100 HP for each 1000 ft. of depth of the well. This is not limited to one and only one size of drill stem, but applies more closely to 4-1/2 in. than to other sizes.

2. For the rotary: We need 100 HP for 100 RPM of the rotary at 10,000 ft. of depth, using 4-1/2 in. drill pipe.

3. Input HP for the pump: $10D^2$ = Required HP Input. This means, take the diameter of the hole (or bit), multiply it by itself and multiply the product by 10.

4. Pump Power Requirement: From 3 to 6 bit hydraulic horsepower per square inch of hole area. As an example, taking a 10 in. hole: 10 x 10 x 0.7854 4 BHHP = 314 BHHP needed.

## Practical Measure of Rig Performance

Aside from the "rules of thumb" just cited, there are no "specs" which set forth the minimum performance of a rig.

Practical Measure of Rig Performance (continued):

A general survey of 1968 practices being followed on a variety of drilling jobs suggests that any rig that can perform as follows is certainly not ready to be junked; in fact, it might make its owner some several more dollars yet:

Hoisting: Starting from rated depth with rated pipe (12,5000 ft. with 4-1/2 in. pipe for example) average a stand of 120 ft. set back every 60 to 80 seconds.

Pumping: Deliver 400 hydraulic horsepower to the bit nozzle with an upward annular velocity of 110 to 150 ft/min of the drilling fluid.

Rotating: Turn the rotary at a controlled rate of from 50 RPM to 250 RPM under varying conditions of weight on the bit and varying torque requirements.

## THE BIT

The bit is an important factor in drilling. If we had bits that would not wear out, or that would drill perfectly no matter how operated, we would not have to have drillers and toolpushers. The whole process could be automated, and programmed to stop when the hole was drilled deep enough. We would not need big rigs for fast trips to pull dull bits, or five or six man crews because it takes only a man or two to make connections. Unfortunately, bits do wear out, often too quickly, and sometimes unanticipated things happen. We need a man to recognize that something has gone wrong, to analyze the situation and make the right decision. The driller must be able to recognize these problems and take appropriate action. Sometimes the driller and toolpusher will have to "out-guess the formation" in order to have the right bit in the hole at the time it is needed.

Bits must be run in the kind of formation best suited to their construction and in a manner that will consistently obtain the best results. Soft formation types are build with long teeth, protected against abrasion by deposits of tungsten carbide. This works fine for the softer rocks, but hard metal will chip off and the teeth will break when run on even moderately hard rocks. Soft formation type bits are built with offset to the cones. This is all wrong for hard formations, which will quickly dull any bit that has much offset. Compressive failure, i.e. crushing, is the only way that dense, hard formations can be drilled. Bits that make hole by the crushing action of the bit teeth must be used at slow rotary RPM. Bits that make hole by shearing or gouging the formation, as the case with drag bits and soft formation rolling cone types, can be run at high rotary speed without detrimental effect.

## THE BIT (continued):

Diamond bits function the same as drag bits, particularly in the fact that both weight and rotary speed are directly related to drilling speed. The diamonds must be kept clean and cool, thus hydraulic effort is just as important for diamond bit performance as when using roller bits.

## DRILLING TIME TESTS

The driller will take an observation periodically of how much time is needed to drill a foot, ten feet, or the kelly down. This time will be converted - usually mentally - into feet per hour, the usual basis for comparing bit performance. Many rigs are equipped with drilling rate recorders which enable quick review and comparison of rates of penetration being obtained.

### Footage Costs

Higher weight dulls bits faster; and bearings wear out faster than when using lower bit weight. Drilling weight usually should be increased as the bit teeth become progressively duller. A careful study of bit records can be of great help in determining the proper type bits to employ and the best operating weight and RPM to employ. Footage per bit and penetration rate have long been the accepted "yardsticks" for evaluating bit performance. These are two different units of comparison; their utilization has to be combined to a money basis for proper comparisons to be made. This can be done by figuring costs per foot as follows:

$$\text{Cost per foot} = \frac{B + R\ (T = t)}{F}$$

$B$ = Bit cost in dollars.
$R$ = Rig operating cost per hour.
$T$ = Drilling time in hours.
$t$ = Trip time in hours.
$F$ = Hole drilled by the bit in feet.

Cost per foot of hole drilled is a true basis of comparison. Rate of penetration as well as bit life must be used in this calculation. Carbide-insert and sealed bearing bits are more expensive but often last longer for more footage. This type of calculation becomes very important on holes that require many bits to reach final depth. Even though a round trip might represent $1000, often the case for large rigs, the lower cost per foot by a different type bit sometimes justifies the trip when hole cost is $100 per foot or more, using the above calculation.

## STUDENT REFERENCE (continued):

### Footage Costs (continued):

Using the formula given previously and assuming rig cost was $100 per hour, hole cost per foot for the last two bits was about as follows:

$$\text{Cost/Foot} = \frac{\$250 + \$100\ (9 + 5)}{550}$$

$$= \$3.00\text{/Foot}$$

Bit Cost = $250
Rig Time = $100/Hour
Drilling Time = 9 Hours
Trip = 5 Hours

### The Action of the Bit

Although weight-on-bit, rotary power, and hydraulic effort are the primary factors for making hole under the control of the driller, the ability of the bit to make hole is drastically reduced by high differential between hydrostatic (borehole) and fluid pressures in the pores of the formation. This effect, "chip hold-down," causes rocks to gain strength thus requiring greater compressive loads before crushing, and the chips that form are more difficult to remove. Drillers have known for a long time that deeper formations were harder to drill than shallow rocks; this was attributed to the fact that older rocks could be expected at depth. Generally, older geological formations have greater compressive strengths than younger rocks. Granite and dolomites will not crush until loadings of 30,000 - 40,000 PSI are applied; these figures compare to 5,000 - 10,000 PSI compressive strengths for chalk and limestones. It has been found by laboratory experiments that many rocks apparently gain compressive strength when subjected to hydraulic pressure.

### The Rotary Factor

In the cable tool system, the driller speeds up the walking beam to get more strokes per minute, thus to obtain faster blows on bottom. In the rotary system the table speed is increased, thus greater RPM, to obtain more turns per minute of the bit on bottom. Usually higher RPM will increase the rate of penetration. That the drilling rate in soft formations will increase as rotary RPM is increased, assuming that the drill string can handle the increased torque, there is enough power available to turn the rotary, and that the higher speeds can be accomplished without excessive vibration of the rig and drill string.

## STUDENT REFERENCE (continued):

### The Rotary Factor (continued):

Less benefit may be expected with more RPM in hard formations. In fact, shock loads can severely damage the bit and drill string at elevated rotary speeds. Shock loads will shatter the bit teeth and cause premature failure in the threaded connections of the drill string. These physical facts impose an upper limit on the rotary speed that can be economically employed when drilling hard rocks. Bit tooth wear assumes critical significance when drilling hard abrasive rocks, and is another reason that slow table speed is more economical when drilling such formations. Rotary power required for slow speed rotation (40 - 60 RPM) is not signigicant.

Drill pipe seldom fails because of excessive torque, most failures occur because of metal fatigue due to notches, imperfections, or corrosion rather than torsional loads. Rotary torque requirements seldom exceed 10,000 foot-pounds, except for very large bits. Long-tooth bits generally require more rotary torque than short-tooth bits to drill the same formations. Higher torque means more horsepower is required to pull the rotary at a given table speed. Slanted holes, and wells with sharp dog legs, require more rotary torque than vertical holes because of greater friction between the drill string and wall of the well.

The power needed to turn the rotary will vary according to the torque and speed of rotation. Part of the requirement is due to friction between the drill string and the walls of the well; at higher RPM it appears about 50% of the total may be due to hole friction.

The driller must be aware of the stress developed by rotary torque and know the capability of his equipment. At high RPM a lot of energy is contained in the rotating mass of the drill string; a sudden seizure of the bit to "lock up" the string can cause a lot of damage to the drill string due to tool joint failure and twist-offs. The practical upper limit of rotary speed appears to be about 300 RPM for drilling soft formations at shallow to medium depths. To usefully employ this speed the drill string must run true; unbalanced centrifugal forces can cause severe vibrations in the drill string and hole friction will be increased. In some instances it will be found that 250 RPM may be the maximum rotary speed that can be employed because of drill pipe failures due to excessive vibration at higher figures.

### Hydraulic Factor of Making Hole

Hydraulic, or fluid, horsepower at the bit is the third significant factor for rotary bit performance. Low powered pumps, operated at low pressure, can cause drilling progress to be painfully slow; high-powered pumps operated properly

## Hydraulic Factor of Making Hole (continued):

will have the effect of making many formations relatively "soft", i.e. they are easy to drill. With low hydraulic power at the bit it will be found impossible to get more hole with added weight and rotary power. The formation will not "drill" no matter how hard the driller works at the job. Conversely, it will be found that more weight on the bit and more rotary will produce more hole when high hydraulic effort is expended through the bit jets. The amount of hydraulic power actually delivered to the bit will depend on the size of the pump, its input power and operating pressure. Large drill pipe with minimum restrictions will enable more fluid at higher pressure to reach the bit than can be pumped through a small diameter drill string. Plastic-lined drill pipe offers less resistance to fluid passage than unlined pipe, thus more of the pressure energy put into the fluid stream will reach the bit.

In a well-designed engine-pump arrangement about 75% of the mechanical input power will be put into the circulating system as hydraulic power in the form of volume and pressure. If the hydraulic circuit is suitably arranged, about two-thirds of the pressure on the fluid as it leaves the pump will be expended through the bit nozzles.

The three factors for making hole - weight, rotary power, and hydraulic power at the bit - are interdependent, i.e. they depend on each other if maximum benefit is to be obtained. The best rate of penetration is obtained when these related factors are at optimum values within the capabilities of the rig equipment. High figures of bitweight and rotary power will not produce faster hole unless hydraulic power at the bit is enough to keep the hole bottom clean. Hydraulic power at the bit depends on the availability of input power for the pump, high pressure operation of the pump, minimum losses in the hydraulic circuit, and optimum volume and pressure at the bit. It has been explained that most of the available pressure from the pump is expended at the bit in a properly designed hydraulic circuit. The hydraulic system of a rotary rig involves losses in the surface connections, the drill string, the bit nozzles and the return annulus.

The main requirement of a rotary hydraulic system is to provide sufficient hydraulic power to the bit to clean the bottom of the hole. Secondly, the circulating system must provide a means of transporting cuttings to the surface and to maintain the walls of the hole in condition for drilling and round trips. Hydraulic power at the bit is obtained primarily by the jet nozzles which hold back-pressure on the fluid. The formula for hydraulic horsepower using terms of gallons per minute and pounds per square inch is as follows:

$$\text{Hydraulic Horsepower} = \frac{\text{Volume (GPM)} \times \text{Pressure (PSI)}}{1714}$$

## STUDENT REFERENCE (continued):

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## Hydraulic Factor of Making Hole (continued):

Hydraulic horsepower maintained at optimum values will clean the hole bottom and let the mechanical forces of weight and rotary power on the bit make faster hole. Pertinent to the best results is the use of low density drilling fluid, thus reduced hydrostatic pressure on the face of the rocks at the bottom of the hole and therefore a low differential between borehole and formation pressure. Clear water enables faster drilling than mud because of its lower density, less hydrostatic pressure, and the lack of a filter cake on bottom to prevent chip removal by jet action. Even fine silt in the drilling fluid will slow drilling; faster penetration can be made when desilters are employed to remove very fine particles in the drilling fluid.

Practical limitations on the hydraulic horsepower that can be put to the bit are:

1) The amount of power available for driving the pump. This is a controlling factor than cannot be overlooked.

2) The allowable pump discharge pressure. This will depend upon the pressure rating of the pump, the liner size employed, or the orders of the contractor.

3) Minimum annular return velocity. One hundred twenty feet per minute may be enough in hard rocks, but sometimes 200 feet per minute will be needed for soft, fast-drilling formations. Usually lower annular velocity can be employed at depth because the drilling rate is slower.

Other conditions which limit the amount of hydraulic power that can be pumped to the bit are well depth, drill pipe size, and mud density. With a given pump horsepower and operating pressure it will be found less power will reach the bit as the well is drilled deeper. This is because of greater losses inside the drill pipe due to the longer distance the fluid must travel. Second, small drill pipe obviously will have greater line losses because of more friction due to turbulence in the small drill string. Third, heavier mud will require more energy for pumping a given volume.

## EVALUATION:

Answer the following questions in writing:

1. Name three drilling problems commonly encountered that are related to the geological section involved at a given location.
2. What are the three main components that control the hole making capability of a drilling rig?
3. Name the three main factors enabling a bit to make hole.
4. As formations become harder, rotary speed should be __________________________.

IV. DUTY: Drilling Operations

TASK 2: Running Casing

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INTRODUCTION:

This leasson will discuss the kinds of pipe used, string design considerations, and running techniques.

LEARNING ACTIVITIES:

1. Attend class slide presentation and discussion.

2. Read student reference section and write 3 questions about the material that you do not understand or would like to know more about.

STUDENT REFERENCE:

Drilling for oil or gas involves two main objectives: (1) to bore a hole to the petroleum accumulation, and (2) to install a pipe from the reservoir to the surface. The pipe is called "casing," and it is usually cemented to insure a pressure-tight connection to the oil or gas reservoir. Casing in a well has six important functions:

(1) To prevent caving of the hole.

(2) To prevent contamination of fresh water in upper sands by fluids from lower zones.

(3) To exclude water from the producing formation.

(4) To confine production to the well bore.

(5) To provide a means of controlling well pressure.

(6) To permit installation of artificial lift equipment for producing the well.

With the cable-tool method numerous strings of casing were set as a well was drilled. But one principal advantage of the rotary method is the fact that much more open hole can be drilled than was ever possible with cable tools. In rotary drilling today open hole can ordinarily be drilled as far as desired because of the better quality muds available. Casing is generally set to serve a specific purpose and is neither arbitrary nor compulsory on account of any certain hole conditions.

The cost of casing is often the greatest single item of expense on a well, and the casing used in a typical well may represent a very large investment. Selection of casing sizes, weights, grades, and types of threaded connections for a given situation constitutes an engineering and economic problem of considerable importance. Assuring good material, running in the well, and cementing in place should be planned procedures.

The drillers and crewmen involved should understand the concepts of casing string design and know how to properly handle pipe while it is on the rack and as it is picked up, made up into the string, and finally cemented in the hole.

## TYPES OF CASING

### Surface Casing

The first string of any consequence that goes into a well is called "surface casing" because it is set deep enough to protect the well from cave-in of loose formations that are often encountered near the surface. It is the starting point for the casing head and other fittings that will be left on the completed well. The setting depth of surface casing may be only 200 ft. or so, but sometimes it is as great as several thousand feet.

The casing selected must be strong enough to support a blowout preventer and to withstand gas or fluid pressures that might be encountered. Surface casing should have the strength to provide a solid anchor for the casing head when the well is put on production. Ordinarily, the burst strength should be equal to 1 psi per foot of depth to which it is set; i.e., if the string is set at 2000 ft., its burst strength should be at least 2000 psi, for that is about the maximum pressure formations encountered at that depth could be expected to contain.

An important factor concerning the amount of surface casing needed (the setting depth) is that the string should be deep enough to reach formations that will not fracture or break down with the maximum weight that may be needed when drilling to the expected depth of the well or to where the next string is to be set.

## Surface Casing (continued):

Surface casing may be used to support part of the suspended weight of casing run into the well after the surface string is set. This is usually accomplished by cementing the surface casing from the shoe to the surface. The inner strings may be suspended by hanging their weight on the casing head. Hanger devices are available that may be placed in the surface casing string a few hundred feet above the shoe, thus permitting part of the weight of an inner string to be supported at that point.

## Intermediate Casing

The primary purpose of an intermediate casing string is to protect the hole; such strings are sometimes termed "protection casing." Intermediate casing is generally employed to seal off weak zones that might rupture with the heavy mud usually needed when deepening a well. Sometimes an intermediate string of casing is used to seal off older producing zones in order to drill for deeper production.

The usual function of this string is to afford protection against loss of circulation in shallow formations when heavyweight mud is needed for drilling deeper because higher pressures are normally encountered. It affords better protection against well pressure than the surface string because its smaller diameter holds more pressure and because it will not be worn out due to abrasion by the drill string. The setting depth of an intermediate string should be enough to reach formations able to hold the mud weight expected to be employed when drilling deeper, as explained for surface casing.

## Casing Threads and Couplings

Casing strengths in tension, collapse, and burst are considered when selecting specific pipe for a given well situation. When casing is run, the couplings forming the joints in the upper section are in tension, i.e., tending to pull apart, because of the weight below them. These joints must have sufficient strength to resist rupture or deformation when under pull-out load. Also, they must be leakproof in tension if the casing string is to perform properly. API round-thread, buttress, and extremeline joints are leak-resistant up to the yield strength of the joint, thus their leak resistance under tension loads is greater than that required in service. Casing may collapse when external pressure, such as the hydrostatic pressure of fluid in a well, exceeds the resistance of the tube to flatten.

## STUDENT REFERENCE (continued):

### Casing Threads and Couplings (continued):

This is related to the thickness of steel making up the tube, the grade of steel, the diameter, and the external pressure applied. Pressures excess to the values given by API cause casing to fail by collapse. Casing may burst due to internal pressure that might be applied. The highest stress usually occurs at the surface when doing a fracture job; in the lower portions of a casing string external pressure due to hydrostatic head offsets internal pressure so that burst stress is not excessive. Collapse and burst pressures given by API are calculated values based on the yield strength of the material, wall thickness, and diameter of the tube.

## CASING STRING DESIGN

Oil well casing strings should be planned to obtain safe operation at a reasonable cost. Casing strings for average well conditions are designed by engineers to withstand three principal forces - tension, collapse, and burst. Since the actual loads can never be exactly anticipated, margins for errors are provided, i.e., design factors are employed to allow some element of safety.

Casing string designers usually select several weights or grades with which to make up a given string, taking into account well depth, expected pressures, and weight of the fluid in the well. Obviously, the strongest pipe for tension must be placed at the top of the string. Bursting load due to internal pressure is greatest at the top, and the danger of collapse is worst at the bottom. "Graded" casing strings take advantage of the fact that lighter weight (and usually lower grade and less expensive) material may be used at various points in the string between the top and bottom sections. By taking full advantage of all economies, savings of 15 - 20% may be realized by using graded strings rather than uniform ones.

Those concerned on the job should take all precautions to insure that the casing is run into the hole in the proper order; a misplaced joint may cause complete failure and loss of the well. If any joint cannot be clearly identified, it should be laid aside until its weight, grade, and type can be positively established.

## CASING STRING DESIGN (continued)

Consideration of special circumstances for each string of pipe should be applied when designing the string. Surface casing is primarily for protection in case of a blowout, so this string is usually designed to withstand a burst pressure equivalent to 1 psi per foot of depth; but the minor threat of collapse at this level is generally disregarded. Intermediate casing is primarily for preventing lost circulation when heavy mud is employed with deeper drilling and for resisting pressure at the wellhead when handling kicks. This string should be designed against burst with an ample safety margin to allow for wear as drilling proceeds after it is set. The production string is the completion or final casing and must withstand forces on the well throughout its active life. This string should be designed to resist expected internal pressures. If tubing is set with a packer, a possible tubing leak might impose well pressure on top of the column of fluid behind the packer. Therefore, considerably more bursting force than well pressure would be exerted. Production strings sometimes are nearly emptied, as when being gas-lifted or produced by a bottom hole pump; this may impose considerable collapse load from hydrostatic pressure on the outside of the string. It is usually assumed that salt water pressure, 0.5 psi per foot of depth, exists on the outside of the production string of casing, but sometimes this may be equal to the weight of the overburden, about 1.0 psi per foot of depth.

Casing testing has assumed much more importance in recent years because higher pressures have been involved, well costs are much greater, and failures can be very expensive. Failure of new casing can be caused by the following: (1) defects during manufacture, (2) damage when handling, and (3) stress concentration cracks. Any sharp notch can be the point of stress concentration and ultimate failure; high quality steel will fail where the metal has been scratched or gouged due to stress concentration. Fine cracks and seams can cause the same trouble.

## CASING SIZE CONSIDERATIONS

The controlling factor in the sizing of the first strings that go into a well is the size desired for the last, the production string. When the diameter of the oil string casing has been established, bit sizes and diameters

CASING SIZE CONSIDERATIONS (continued)

of the intermediate and surface casing strings may be determined. When selecting hole size for a given casing OD (outside diameter), it is necessary to consider the coupling OD and provide sufficient hole clearance to allow for mud cake, etc.

Several factors should be considered when selecting the production string to be employed. Well cost will increase as hole diameter is increased; the cost of a large diameter hole should be compared to the economic gain obtainable. Method of production controls the choice of pipe size because a flowing well might have to be pumped or gas-lifted in its later life. Rate of production is an important consideration when large volumes of gas or oil are involved. Multizone production may require several strings of tubing to satisfactorily produce the well. If several intermediate strings are needed, the oil string may have to be fairly small unless large casing is set at the start of the well. Large holes and heavy strings of casing may necessitate a larger drilling rig than the economics of the production can justify. If remedial work is likely, the size of the oil string should be large enough to accommodate the necessary tools. Sometimes the availability of certain sizes of casing is the determining factor for the choice of the production string. Finally, common practice in a given area is often the deciding factor in the choice, because the rigs in that area are fitted for certain work, tools for a given size of casing are readily available, and delays may be minimized.

## RUNNING CASING

As stated in the introduction, one of the primary objectives when drilling a well is to assemble and run a string of casing that will satisfactorily produce oil or gas from the reservoir. The hole must provide enough clearance so that the casing and couplings can be lowered freely into the well; the drilling fluid should be in condition to permit free circulation around the casing; and the hole should be in suitable condition so that the casing job can be done. Usually, after final depth is reached, there will be a period of waiting for the final order to run casing while electric logs, cores, and other information are being studied. The toolpusher and drillers often have access to much of this information and occasionally take part in the discussions; therefore they have some prior knowledge that

## RUNNING CASING (continued):

pipe may be set or the hole plugged. During the waiting period, the driller and crew should take advantage of the temporary lull in order to prepare the rig equipment and machinery for the anticipated work. Drill pipe may be sorted out on the pipe rack to make room for the casing that will soon arrive on the job. Brakes may be tightened and the drilling line inspected, if a casing job is the next step. The engines should be checked for proper running condition; fuel and water supplies must be assured.

### Preparing the Hole

The first consideration (but not necessarily the first step) preliminary to running casing is to insure that the hole is in suitable condition. Usually drill pipe will have been out of the hole a matter of 12 - 24 hours while surveys and other information were being obtained prior to the decision to set casing. This means that filtercake will have had time to build up on the permeable sections of the hole, perhaps sufficiently so to close the annulus and form an obstruction that could stick the casing or make circulation impossible. Cuttings or sloughed shale may have settled in the hole to such an extent that casing could not be run to bottom without circulation. The usual procedure is to go into the hole with one stand of drill collars and a used bit, just in case bridges are encountered. Drill pipe measurements should be carefully checked even to the extent of obtaining new figures to be totalled again. Once on bottom, TD is double checked and circulation started; the mud should be pumped around at least twice while properties of weight, viscosity, and fluid loss are observed.

### Preparing the Rig

Preliminary checks can be made of the rig machinery while waiting on orders to run casing. This should include visual inspection of the braking system on the draw-works and the drilling line. Usually the first consideration when orders are received to run casing is to restring the blocks to 10 or 12 lines. This nearly always involves a "cut"

## Preparing the Rig (continued):

of the line as well as stringing more lines; sometimes the additional string-up requires a new drilling line. The derrick or mast should be given a visual check by the derickman, foundations checked, and the derrick "plumbed" if not absolutely vertical. If a very heavy string of casing is to be set, rig builders may be called out to check the bolts in the derrick for tightness. While this work is going on, the derrickman is expected to examine the liners, pistons, valves, and seats in the mud pumps, so as to be certain that this equipment will be in good shape when needed. Extra drill collars should be laid down and preparations made to lay down drill pipe when pulling out after conditioning the hole. Drill pipe is usually laid down when pulling out; special equipment and extra men are often employed for this work. Sometimes only a part of the drill string is laid down.

After pulling out of the hole preparatory to a casing job, the blowout preventer rams should be changed from drill pipe to the casing size to be run. This job may often be accomplished while preparations are being made on the floor and in the derrick to start picking up casing.

When the drill pipe is out of the hole, the drill pipe elevator is removed - sometimes special elevator bails are used - and a heavy-duty elevator to fit the casing is installed. A slip elevator is recommended for heavy strings of casing. If a collar-pull elevator is used, the bearing surfaces should be carefully checked for (1) uneven wear which might produce a side lift, and (2) uniform distribution of the load over the bearing face of the couplings. If a slip elevator and spider are employed, the slips should be examined and watched to see that they all lower together. Care must be exercised, particularly for long strings, that the slip bushing or bowl is in good condition. One or more boards should be rigged in the derrick, so that the derrickman can stand to handle the individual joints of casing and guide the elevators into position on this pipe.

The usual arrangement for picking up casing is to use the catline to lift each length from the catwalk to the derrick floor. A pickup line is attached to the drilling hook to raise the individual casing lengths into the derrick preparatory to stabbing. The casing elevator is not latched to the pipe until the joint has been made up tight.

## Preparing the Rig (continued):

The drilling hose should be disconnected from the swivel if the plan for the job provides that the drilling hose be attached to the cementing head and the rig pump used for pumping down the cement plug. An arrangement for filling the casing as each joint is made up in the string should be provided. If the rig pump is to be used for this purpose, a flexible line to a fluid line on the floor should be connected, with a quick-closing valve put on the outlet end. This arrangement allows the man watching the fluid level in the casing to have full control of the fluid flow and thereby prevent overflow onto the floor.

## Casing Tools and Crew

If only a few joints of casing are to be set - for example, a short string of surface casing - a spinning rope and tongs usually suffice for the job. Run-in time may be only an hour or two, so the work can be done by the regular crew without much delay or exertion. An experienced casing crew is invaluable for the actual job of running casing into the hole. Powered casing tongs insure proper make up of each threaded joint. Most casing crews can provide the additional items that facilitate the job. These include a quick-release thread protector to eliminate the delay involved by a balky metal protector that sometimes becomes fouled on the threads, a quick-opening valve for filling each joint as it is run, a pick-up line, and a derrickman skilled in the art of stabbing casing into perfect alignment for make-up.

Power tongs for casing, are desirable for a long string of casing not only as a labor-saving device, but also to eliminate the hazards of a spinning rope, jerk line, and cathead. Thread make-up torque can be controlled precisely with a power tong properly operated. Most casing tongs are powered hydraulically, but some are run by compressed air. Most of them can be opened for removal from the casing.

An experienced casing crew is desirable on a heavy casing job because the work is hazardous and the hours are long. And these extra men are needed in any case. Slight carelessness on the part of a tired man can be the cause of a severe injury or damage to an expensive well.

## STUDENT REFERENCE (continued):

### Preparing the Casing

All casing, whether new, used, or reconditioned, should be handled with the thread protectors in place until it is on the pipe rack at the location where it is to be run. The minimum procedure is to visually inspect each joint as it is rolled on the pipe rack. Pipe that has been dented or scarred should be put aside. The pipe should be racked with the collars toward the rig and aligned in an orderly manner. Board slats should be placed between each layer in such a fashion that the joints of the upper layers can be rolled easily to the catwalk. If a graded or mixed string is involved, the pipe should be placed on the rack in the reverse order of running, i.e., the last joints to be stacked on the rack will be the first to go into the well. If the string includes pipe of different thread forms, the "cross-over" lengths should be accessible on the rack so that the matching threads will fit properly. After all the pipe is on the location, an exact count of the number of joints on the job should be obtained and this total should be compared with the number of joints described by the shipping papers.

Unless there are arrangements for inspection and testing, usually made by specialists, thread protectors from both field and coupling ends of the casing in the top layer are to be removed and the threads cleaned and inspected. This procedure should be repeated as the lower rows of pipe in the stack are uncovered. If the casing is delivered with couplings handling-tight, the couplings must be removed so the mill-end threads can be cleaned. The exposed threads should be inspected and cleaned and fresh thread compound applied. A special thread protector should be used when casing is rolled off the rack and pulled into the derrick. If the couplings are removed, or if standoff of a mill-installed coupling appears abnormally great, they should be tightened carefully before the pipe is pulled into the derrick. Each joint of casing should be rolled carefully across the rack and lowered to the catwalk using a rope snubber, rather than being dropped off the top of the stacked pipe.

Casing accessory devices are often installed while the pipe is on the rack, sometimes by welding. But most scratchers and centralizers can be obtained in forms that do not require welding, thus certain adverse effects can be completely avoided. Welding can cause stress concentrations in the metal that may result in pipe failure; it has been determined that the usual tack-welds can be broken by drilling inside casing. The commercially available thread-locking compounds, properly applied, will prevent

## STUDENT REFERENCE (continued):

### Preparing the Casing (continued):

joint back-off. Drilling engineers recommend that mill-installed couplings on the bottom 4 - 6 joints of casing be removed, the threads be thoroughly cleaned, and they be reinstalled with a good thread-locking compound.

Thread-locking compounds are mixed on the job immediately prior to use; a paste-like mixture results that will harden into a solid in a very short time. After mixing, the material is spread on the first two-thirds of the male threads and the joint tightened in the usual fashion. When the compound hardens, it will be found that the break-out torque requirement is about four times the make-up figure. Thread-locking compounds are also very effective as pressure sealants.

### Casing Measurements

An important part of every casing job is the measurement, or tally, of the pipe. Notwithstanding that most depth determinations of the producing formations, perforating intervals, etc., are by electric log measurements, it is most important to have a record of how much casing is run into a well. One common error is to leave out a joint; conversely, one joint too many may go into the string; less frequently, a 100-ft. mistake (usually in addition) is made. The number of such mistakes can be minimized if strict attention is given to the job of measurement and common-sense procedures are followed.

A significant change in recent years for handling casing has been the shift from oil company warehousing to mill-operated, in-transit, and field terminal stock points. This has improved the availability of various sizes and grades and has reduced mechanical damage by less movement and handling. Pipe obtained from these stocks have joint-counts, weight checks, and tallies that are nearly always correct. Shipping papers that accompany a string of casing to a well by this procedure constitute the first measurement check. A rough check on the footage of pipe in a well makes use of the "threads-on" tally of the pipe that is shipped to the job. Thread make-up, of course, varies according to the size of the pipe and the type of threads, but is usually within 1% of the total length. The net length of a string is about 1% less than the "threads-on" tally; this figure divided by the number of lengths shipped equals the average length of the joints in the string. The average length times the number of joints set in the well approximates the setting depth.

## Casing Measurements (continued):

The most important point concerning pipe measurement is knowing exactly how many lengths are on the job. This starts, as stated above, with the joint-count when the pipe is shipped to the location. Second, an accurate joint-count must be made when the casing is received. The final count is made of the remaining balance after the casing string is run. Casing in the hole must be the difference between the total number of joints that came onto the location - less any that may have been shipped away - and the number of joints on hand at the end.

The individual lengths in the string should be numbered in the order in which they are to be run into the well. Different weights or grades should be clearly marked. Each casing joint must be measured, preferably with a steel tape graduated in feet, tenths and hundredths of a foot (or in metric equivalents). The measurement of each length should then be recorded on a tally sheet and blocked in groups of ten. The tape should be read to the nearest hundredth of foot from the top end of the coupling to the first scratch of the run - out for round-thread casing, or between the shoulders for extreme-line. The columns of ten are then added. Inspection of these totals quickly shows where errors of addition may have been made, for the group totals should approximate ten times the average length of each joint.

## Stabbing, Making Up, and Lowering

When a length of casing is pulled to the derrick floor, it should be handled carefully; a hold-back rope should be provided to prevent the pipe from striking the derrick or rotary. A clean thread protector should be on the threads as the joint is picked up from the catwalk. As previously shown, this should be a quick-release type that can be removed with minimum effort and with little chance of fouling on the threads. If necessary, apply thread compound over the entire surface of the threads just before stabbing. The brush used in applying thread compound should be kept free of foreign matter and the compound should never be thinned.

When stabbing, lower casing carefully to avoid injuring the threads. Stab vertically, preferably with the assistance of the derrickman on the stabbing board. After stabbing, the casing should be rotated slowly at first to insure that the threads are properly engaged and not cross-threaded.

Stabbing, Making Up, and Lowering (continued):

The following recommendations are taken from API RP 5C1 for casing make-up using a spinning line and conventional casing tongs:

Tighten with tongs to proper degree of tightness. The joint should be made up beyond the handtight position at least 3 turns for sizes 4 1/2 - through 7-in., and at least 3 1/2 turns for sizes 7 5/8-in. and larger. When using a spinning line it is necessary to compare handtightness with spin-up tightness. In order to do this, make up the first few joints to the handtight position, then back off and spin up joints to the spin-up tight position. Compare relative position of these two make-ups and use this information to determine when the joint is made up the recommended number of turns beyond handtight.

Joints that are questionable as to their proper tightness should be unscrewed and the casing laid down for inspection and repair, if practical. When this is done, the mating coupling should be carefully inspected for damaged threads. Parted joints should never be re-used without shopping or regaging, even though joints may have little appearance of damage.

If casing has a tendency to wobble unduly at its upper end when making up, indicating that the thread may not be in line with the axis of the casing, the speed of rotation should be decreased to prevent galling of threads. If wobbling should persist despite reduced rotational speed, the casing should be laid down for inspection. Serious consideration should be given before using such casing in a position in the string where a heavy tensile load is imposed.

In making up the field joint it is possible for the coupling to make up slightly on the mill end. This does not indicate that the coupling on the mill end is too loose, but simply that the field end has reached the tightness with which the coupling was screwed on at the mill....

API recommendations for the make-up of casing using power tongs are:

Casing Make-Up. The following practice is recommended for making up 8-round thread casing.

## STUDENT REFERENCE (continued):

### Stabbing, Making Up, and Lowering (continued):

a. The power tong should be provided with a reliable torque gage of known accuracy. In the initial stages of make-up, any irregularities or make-up or in speed of make-up should be observed, since these may be indicative of crossed threads, dirty or damaged threads, or other unfavorable conditions.

b. Continue the make-up, observing both the torque gage and the approximate position of the coupling face with respect to the last scratch position.

c. The optimum torque values shown in the following tabulation have been selected to give optimum make-up under normal conditions and should be considered as satisfactory providing the face of the coupling is flush with the last scratch or within two thread turns plus or minus of the last scratch.

d. If the make-up is such that the last scratch is buried two thread turns and the minimum torque shown in the tabulation is not reached, the joint should be treated as a questionable joint.

e. If several threads remain exposed when the optimum torque is reached apply additional torque up to the maximum shown in the tabulation. If the standoff (distance from face of coupling to last scratch) is greater than three thread turns when the maximum torque is reached, the joint should be treated as a questionable joint.

f. It is advisable when starting to run casing from each particular mill shipment to make up sufficient joints to determine the torque necessary to provide a make-up of three turns beyond the hand-tight position. These values may indicate that a departure from the recommended optimum values (see tabulation) is advisable. If other optimum values are chosen, the minimum torque should be not less than 75% of the optimum torque. The maximum torque should be not more than 150% of the optimum torque.

STUDENT REFERENCE (continued):

Stabbing, Making Up, and Lowering (continued):

Recommended Casing Make-Up Torques
8-round-thread Casing

Torque, ft - lb

| Casing Size OD In. | Optimum | Minimum | Maximum |
|---|---|---|---|
| 5-1/2 | 2650 | 2000 | 4000 |
| 6-5/8 | 3150 | 2400 | 4700 |
| 7 | 3800 | 2800 | 5700 |
| 7-5/8 | 3800 | 2800 | 5700 |
| 8-5/8 | 4100 | 3100 | 6100 |
| 9-5/8 | 4700 | 3500 | 7000 |
| 10-3/4 | 4900 | 3700 | 7300 |

Although nearly all casing strings reach bottom, can be circulated, and are cemented as planned, there are occasions when trouble develops and a string on pipe has to be pulled. API recommendations in RP 5CI, issued March 1963, for the recovery of casing states:

Break-out tongs should be positioned close to the coupling but not too close since a slight squashing effect where the tong dies contact the pipe surface cannot be avoided especially if the joint is tight and/or the casing is light. Keeping a space of 1/3 to 1/4 of the diameter of the pipe between the tong and the coupling should normally prevent unnecessary friction in the threads. Hammering the coupling to break the joint is an injurious practice. If tapping is required, use the flat face, never the peen of the hammer, and under no circumstances should a sledge hammer be used. Tap lightly near the middle and completely around the coupling, never near the end nor on opposite sides only.

Great care should be exercised to disengage all of the thread before lifting the casing out of the coupling. Do not jump casing out of coupling.

All threads should be cleaned and lubricated or should be coated with a material that will minimize corrosion. Clean protectors should be placed on the pipe before it is laid down.

Before casing is stored or re-used, pipe and thread should be inspected and defective joints marked for shopping and regaging.

STUDENT REFERENCE (continued):

## Fluid Circulation

A primary prerequisite for a good casing job is that the bore hole must be in good shape and cleaned of cuttings and excess wall cake before cementing. Failure to thoroughly condition the hole or to treat the mud properly has been the causes of stuck pipe, poor cementing, extra well cost for cement squeeze work, or even redrilling the hole. Sometimes the hole is bridged, or casing cannot be circulated, so the string must be pulled and a trip made with drill pipe to condition the well bore.

The usual procedure is to fill the casing periodically as the pipe is run into the well, unless automatic fill-up float equipment is employed. Casing should be filled as it is run for two reasons:

(1) If the casing is filled as each joint is added, there will be less time for the string to be motionless while completely filling when the pipe is near the bottom of the hole. Many strings have become stuck while filling the pipe.

(2) Large-diameter casing may collapse if run into the hole too far before filling, due to unbalanced pressure on the outside of the pipe.

The use of a light-weight filling line with a quick-opening valve is common practice. The usual procedure is to fill each joint while the next length is being picked up and prepared for stabbing. Inasmuch as it is generally not possible to fill the joint completely, most jobs stop running casing and fill completely about every ten joints.

## LANDING THE CASING STRING

Casing landing concerns the transfer of the casing string weight to the wellhead, usually by means of a casing hanger that seats in the casing head and seals the annulus between the outer and inner strings. The operator is concerned with the amount of stress that might be imposed on the other strings and what might happen to the string of pipe being slacked off. The hanging load, or the amount of weight transferred to the casing head, must take into account the strength of the outer casing strings and the load-carrying capacity of the casing head and casing hanger.

LANDING THE CASING STRING (continued):

The amount of slack-off must take into account the possibility of buckling the string; conversely, its tensile strength must be considered if additional pull-up strain is taken. The effects of slack-off on the collapse or burst resistance must be considered when landing a string of casing. Casing is in tension at the wellhead when it is cemented, and it is subject to stretch due to its own weight. An API committee on casing landing practices in 1955 recommended generally that casing should be landed with the same weight on the casing hanger as was supported by the elevator, i.e., no weight should be slacked off or picked up. This recommendation applied to all wells where mud weight was less than 12.5 ppg, where standard design factors of tension and compression were employed, where wellhead equipment could support the load without damage to the casing, and where the surface casing could withstand the loads in compression without failure, taking into consideration additional loads brought about by future operations. This analysis requires some estimate of the future producing conditions in the well.

Consideration of the amount of slack-off or pickup when landing casing in a deep well is most important because hanging loads are greater, more stretch is involved, and temperature changes can be excessive. For each degree Fahrenheit change in temperature of tubing or casing hanging in a well, if the strings are fixed at both ends, there will be 207 psi increase or decrease of metal stress for each square inch cross section of the tube involved.

Practically speaking, it is never possible to completely anticipate all the changes of physical conditions that might occur during the life of a producing well. For this reason the API recommended procedure - landing casing at the wellhead in exactly the position it had when cemented - is a reasonable compromise. The usual design factors for tension, burst, and collapse have sufficient safety margins to handle most of the load changes that occur. Very deep wells, if temperature or pressure changes are expected to fluctuate widely, should be given special attention by technically qualified people.

LANDING THE CASING STRING (continued):

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EVALUATION:

Answer the following questions in writing:

1. State 5 of the main functions served by casing in a well.
2. Name the 3 principal forces that casing strings are designed to withstand.
3. Give 3 reasons why power tongs should be used for making up casing.
4. What is used on the male threads just before the joint is tightened.
5. When should the thread-lucking compound be mixed and applied to threads?
6. Why are thread protectors used?

IV. DUTY: Drilling Operations

TASK 3: Fishing

INTRODUCTION:

In this lesson the reason for fishing, the types of fishing equipment, and the types of fishing tools will be covered.

LEARNING ACTIVITIES:

1. You will attend a classroom presentation about fishing with slides, diagrams, and samples of fishing tools.
2. Read the student reference section and write down 3 questions that you have about the material.

STUDENT REFERENCE:

FISHING TOOLS AND ACCESSORIES

You're in trouble when the rig moves in on a workover job. This tongue-in-cheek statement may not be literally true, but more often than not a fish is in the hole when a workover is started. A fish is a part of a string of pipe or sucker rod or any other sizable piece of metal that is loose in a well. The trouble may have been caused by mechanical failure, corrosion, or abrasion. The subsequent operation to recover anything left in a well is a fishing job.

Sucker rod fishing jobs are nearly always handled by the well servicing crew. If the sucker rods left in a well cannot be caught and recovered quickly, the crew will pull the tubing, just as they would for a stuck pump. Recovering parted tubing can be difficult, but usually a fishing job for tubing requires little more than running the fishing tool. Sometimes, the job gets more involved. The top of the tubing might be damaged so that it cannot be caught easily, for example, or it might be stuck because of a frozen packer. This type of cleanout may require a specialist - a fishing tool operator - to direct the work. Larger rig equipment may be required because of the need to handle drill pipe instead of tubing or to have a rotary or power swivel to turn the work string, which may be tubing or drill pipe.

STUDENT REFERENCE (continued):

FISHING TOOLS AND ACCESSORIES (continued):

Fishing, either in open hole or inside casing, involves the following tools and accessories.

- Taps and die collars
- Spears and overshots
- Internal and external cutters
- Milling tools
- Washover pipe
- Junk retrievers and magnets
- Accessories such as bumper jars, mechanical or hydraulic jars, safety joints, and basket subs

## Taps and Die Collars

Taps and die collars were employed by the earliest drillers before the rotary system came into use. Made of case-hardened steel, they function as threading tools to cut threads on the upper end of a fish. This permits the part left in a well to be pulled. Taps and die collars can be threaded in either direction, depending on the run of the threads, but they cannot be used to catch a fish that is free to turn. The only way to release taps and die collars is by breaking the tool or by stripping the threads.

Before more advanced tools were designed, a tap or die collar would be run on left-hand-threaded pipe to recover right-hand-threaded pipe. Tightening the run-in string to the left (counterclockwise) would tend to unscrew the right-hand-threaded fish, thus permitting the recovery of one or more joints on every run. A fishing tap is sometimes employed instead of a spear because a tap can be made much stronger. Older taps and die collars, sometimes called box taps, have longitudinal grooves across the threads and will leak if subjected to fluid pressure.

## Spears and Overshots

A spear is constructed to obtain a friction grip inside a hollow fish; the female counterpart, an overshot, catches the outside of a fish. Both tools today have pressure sealing elements, so they can be used to permit circulation through a pipe fish. Other than circulation, their principal advantage is that they can be lowered over the top of a fish and the slips engaged without rotation of the fishing string. By the same token, spears and overshots can be released from a fish by rotation, usually by turning to the right.

## Spears and Overshots (continued):

The overshot is the most rugged fishing tool because more metal can be built into the body of the tool than into any tool that goes inside a fish. This is the reason that an overshot is preferred whenever it can be used. In the larger sizes, however, spears and overshots can be made about equal in strength.

## Internal and External Cutters

Cutters are used to remove the upper portion of a stuck string, and other devices are used to recover the remainder. Rotary internal cutters were first designed to cut off casing that would otherwise be left in an abandoned well. These were reduced in size for cutting drill pipe or tubing, and small pipe was used for the run-in-string. Until the advent of the string-shot technique, inside cutting was the best way to loosen stuck drill pipe or tubing. The string-shot back-off procedure has almost completely replaced inside cutting, but the latter method is still used to recover large-size casing.

External cutters are used to make mechanical cuts when the inside of a fish is plugged and does not allow string shots, shaped charges, or chemical cuts to be employed. An external cutting tool is usually run in conjunction with a washover pipe, and a considerable length of fish is washed over before the cut is made. After washover, the common procedure is to pull out of the hole and put the cutter on. This allows the fish to be both cut and retreived with the cutter, thereby saving a trip to run the overshot.

## Milling Tools

Milling shoes and cutters are used to smooth off the top or enlarge an opening in a fish to permit other devices to go over, inside, or around the object. Flat-bottom or bladed mills are used to grind up or cut through solid metal objects in a well.

Milling cutters originally used for cleanout work were made of case-hardened steel shaped the same as machine tool cutters. Later, the cutting edges were coated with a hard metal applied by welding. Until the use of tungsten carbide, few mills lasted very long; they usually wore out in a few inches or feet because of the abrasive conditions at the bottom of a well. During the 1950's, it was learned that embedding relatively large pieces of fragmented tungsten carbide on the cutting edges of the milling

## Milling Tools (continued):

cutters made the tools last indefinitely. Mills tipped with this material have made phenomenal runs when cutting steel in a well. It is not surprising that fragmented tungsten carbide has completely taken the place of other material for the cutting edges of downhole milling tools.

## Washover Pipe

Washover pipe is used to go down over a drill pipe or tubing fish to enable sand or shale in the space outside the fish to be flushed out by circulation. A lipped, concave, flat-bottom, or toothed shoe is usually screwed on the lower end to guide the pipe over the top of the fish. If milling is necessary, the shoe will be tipped with fragmented tungsten carbide. If the inside of the fish is plugged, an external cutting tool is placed on the lower end of the washover pipe to make an outside cut on the fish when the washover is completed. A hydraulic tool that is run on a wireline and operated by mud or water pressure is now available; it is used to clean out the inside of a plugged fish so that a string shot can be run.

Washover, or wash, pipe can be assembled using regular casing, but employing the best materials available is a better practice because of the high stresses involved. Integral threads which tighten against a shoulder, are stronger than tapered-thread and coupled joints. The diameter of the pipe selected for a washover job depends on the diameter of the fish. Although it is desirable if the washover pipe provides as much as 1/2-inch clearance around the drill pipe or tubing over which it is to be run, washover is still possible with as little as 1/8-inch clearance. Washover-pipe assemblies as long as 1,000 feet are sometimes used, but a standard rule is 300 feet of wash pipe. Jars, bumper subs, and safety-release accessory devices are usually placed in the work string above a washover assembly.

## Junk Retrievers

Junk retrievers are tools that are used to recover small objects such as bit or cutter parts, metal pins, or wrenches that might be dropped or left in a well. The usual retriever is a circulation device made in the shape of a short core barrel, which is a tool used to cut a ring, leaving the center undisturbed, with a catcher to take a friction grip on the center portion. Its effectiveness for fishing small pieces is improved by reverse circulation.

## Junk Retrievers (continued):

After being worked to bottom, a ball is dropped in the run-in string; this ball causes circulating fluid to pass out of the device through the side, creating reverse circulation to wash loose pieces into the tool. Another simple device, the fishing magnet, utilizes a powerful permanent magnet to catch metallic objects left on the bottom of a well.

## Fishing Accessories

### Bumper Jars

A bumper jar is an expansion joint device that permits vertical movement of the upper section without movement of the lower part of the tool within a limited range, usually 12 to 36 inches. It is constructed with a square or hexagonal connection so that the bottom will turn with the top section, and it can be pumped through under high pressure without leaking. Raising the upper section with the working string to the limit of travel will produce a light upward jar on the lower section. Dropping the string quickly will produce a sharp downward jar, or bump, on the lower part. If the fish can be freed by a downward blow, a bumper jar can be very effective. The jarring blow will be more pronounced if a few drill collars are placed in the string just above the bumper jar.

### Mechanical or Hydraulic Jars

Often, a powerful upward jar is needed to free a fish stuck in a well. Mechanical or hydraulic jars deliver an upward impact by the sudden release of tripping devices inside the tools. The force of the mechanical jar depends on the amount of torque turned against the trip mechanism - the greater the torque, the harder the jarring blow. Hydraulic jar intensity depends on the pull taken on the tool before it trips - the more the pull, the harder the blow. The effect of a mechanical or hydraulic jar is enhanced by a few drill collars above the tool. A new tool, an accelerator, increases the effectiveness of the jars. It is placed on top of the drill collars and is run in conjunction with the bumper sub and the hydraulic and mechanical jars.

## STUDENT REFERENCE (continued):

### Fishing Accessories (continued):

### Safety Joints

A safety joint is basically a special sub containing right-hand threads that be easily disengaged by left-hand rotation. A safety joint thus can be used to disengage or release the assembly of tools attached to a fish when it cannot be retrieved. For this reason, most prudent operators will run a safety joint above an overshot or other fishing tool as a releasing device in case the fish cannot be pulled or the releasing device in the fishing tool becomes inoperative. A safety joint is sometimes selectively disengaged by a string shot placed adjacent to the tool. Many tools have built-in safety joints in the factory assembly.

### Basket Subs

Basket subs are usually run just above a bit or mill and are used when cleaning out. The force of the circulating fluid on bottom and the agitation caused by the tool will usually carry chips, bits of metal, and so forth up the hole. Fluid return will slow opposite the opening at the top of the basket, thus allowing debris to fall back, generally into the receiver of the tool.

## EVALUATION

Answer the following questions in writing:

1. Name 5 fishing tools and tell their uses.
2. What is washover pipe?
3. Name 2 fishing accessories and tell their uses.
4. Why may fishing be necessary?

## V. DUTY: Equipment Familiarity

### TASK 1: Become Acquainted with the Rotary Drilling Rig and Its Component Parts

### INTRODUCTION:

As a new member of the drilling crew this lesson will acquaint you with the rotary drilling rig, its component parts, their function and the safety provisions of the equipment.

### LEARNING ACTIVITIES:

1. Read and prepare 3 questions about the student reference material.
2. Attend a lecture/demonstration and class discussion.

### STUDENT REFERENCE:

Most rigs are owned by an individual or a firm known as a drilling contractor. However, most holes, or wells, are owned by companies engaged in finding, producing, or refining petroleum. These companies are often called operators, or operating companies. Representing the operator is the company man, or drilling foreman. The operator hires, or contracts, the drilling contractor to drill the well. The oil operator usually contracts to pay a certain sum per foot of hole when, and only when, the well is completed to a specified depth. Sometimes, in special cases, drilling contracts are drawn on a daywork basis, which means that payment is made for each day the rig is used, plus certain extras.

Both the operator and the contractor are interested in such details as the time required for completing the job; the safety of the equipment, property, and personnel throughout the operation; and the ability of both the men and the equipment to do acceptable work.

STUDENT REFERENCE (continued):

The contractor must provide equipment and machinery of sufficient strength and power to drill to the specified depth, be it 2,000 or 20,000 feet. Basically, this equipment consists of hoisting, circulating, and rotating components, a derrick or mast to support them, and power to drive them.

## Derrick or Mast

A derrick or mast is the steel structure that supports many feet of drill pipe, often weighing more than 100 tons.

A standard derrick is a structure with four supporting legs resting on a square base. It can be assembled piece by piece each time a well is drilled. In contrast, the mast is assembled once when it is manufactured. After manufacture, it remains a single unit and is raised, and lowered each time a well is drilled.

The mast or derrick is erected on a substructure, which serves two main purposes: (1) to support the rig floor, providing space for equipment and workers, and (2) to provide space under the floor for special, large valves called blowout preventers.

The substructure supports not only the rotary table, but also the full load of the drill stem when the stem is suspended in the hole by the slips. It also supports a string of casing when the casing is being run in the hole by an arrangement of slips resting on the rotary or when it is being temporarily stored on the substructure. The rig floor also holds the drawworks, the driller's control panel, the doghouse, and other related equipment.

Derricks and masts are rated according to the vertical load they can carry and the wind velocity they can withstand from the side. Derrick load-bearing capacity figures may vary from 250,000 to 1,500,000 pounds. A typical mast or derrick can withstand winds of about 100 to 130 miles per hour with the racks full of pipe and without the need for external guy wire attached to ground anchors

Another consideration in the design of the mast is height. The derrick or mast and its substructure support the weight of the drill stem at all times. The height of a derrick or mast does not affect its load-bearing capacity, but the length of the sections of drill stem to be removed from the hole is limited by the height of the derrick or mast. This is because the crown block must be sufficiently elevated above the derrick floor to permit the withdrawal and temporary storage of the drill stem when it is pulled from the well to change bits or for other reasons.

## Power Systems

### Prime Movers

Most rigs today use internal-combustion engines as prime movers, and most engines are diesels, although some are still in use that burn natural or liquefied petroleum gas a fuel. Rig engine power may range from 500 to more than 5,000 horsepower.

### Power Transmission

Two common means are used to transmit the power from the prime movers to the rig components; mechanical and electrical.

On a mechanical-drive rig, the power is transmitted from the engines to the drawworks, pumps, and other rig machinery through an assembly known as the compound. The compound consists of clutches, couplings, sprockets, belts, pulleys, and shafts, all of which function to achieve the transfer of power.

On a diesel-electric rig, diesel engines, which on land rigs are usually located at ground level some distance away from the rig floor, drive large electric generators. The generators, in turn, produce electricity that is sent through cables to electric switch and control gear. From here, electricity goes through additional cables to electric motors that are attached directly to the equipment involved-drawworks, mud pumps, and the rotary.

## Hoisting System

### The Drawworks

The drawworks, sometimes called the hoist, is a big heavy piece of machinery that consists of a revolving drum around which the wire rope, called the drilling line, is spooled or wrapped. It also has a catshaft, a kind of axle that crosses through the drawworks, that has a revolving drum (called a cathead spool) on either end and two special catheads. Several other shafts, clutches, and chain-and-gear drives facilitate speed and direction changes.

The two main purposes of the drawworks are (1) to lift pipe out of the hole and (2) to lower the pipe back into the hole.

One of the outstanding features of the hoist is the brake system, which enables the driller to easily control a load of thousands of pounds of drill pipe or casing. On most rigs, there are at least two brake systems.

An integral part of the drawworks is a system of speed changes (transmission system). This transmission system gives the driller a wide choice of speeds in hoisting the pipe.

## Blocks and Drilling Line

The traveling block, crown block, and drilling line are the three components whose function it is to support the load of pipe in the derrick or mast as it is lowered into or withdrawn from the hole. During drilling operations, this load consists of the hook, swivel, kelly, drill pipe, drill collars, and a bit attached to the bottom of the drill collars. During cementing operations, a string of special pipe called casing, often a heavier load than the drill pipe and collars, has to be lowered into the hole and cemented.

Drilling line is usually made of wire rope that generally ranges from 1 1/8 inches in diameter. The line should be frequently inspected to ensure that it is in good condition. The drilling line should be moved periodically (slipped is the field term) so that it wears evenly as it is used.

The part of drilling line running out of the drawworks up to the crown block is called the fastline-fast because it moves as the traveling block is raised or lowered on the derrick. The end of the line that runs from the crown block down to the wire-rope supply reel is then secured. This part of the line is called the deadline-dead because, once it is secured, it does not move. Mounted in the rig substructure is a device called a deadline anchor. The deadline is firmly clamped to the anchor. Now the traveling block can be raised up off the rig floor and into the derrick by taking in the line with the drawworks. To lower the traveling block, line is let out of the drawworks drum.

## Rotating Equipment

The rotating equipment from top to bottom consists of the swivel, the kelly, the rotary table, the drill stem, and the bit. The drill stem is the assembly of equipment between the swivel and the bit, including the kelly, drill pipe, and drill collars. The term drill string simply refers to the drill pipe and drill collars; however, in the oil patch drill string is used to mean the whole works.

## Swivel

A swivel is a remarkable mechanical device. It is attached to the traveling block by a large bail. The swivel has three main functions: (1) it supports the weight of the drill stem; (2) it allows the drill stem to rotate; and (3) it provides a pressure-tight seal and passageway for the drilling mud to be pumped down the inside of the drill stem.

## Kelly and Rotary Table

The kelly is a three-, four-, or six-sided length of pipe, about 40 feet long, that is the uper part of the drill stem. It serves as a passageway for the drilling fluid on its way into the hole and transmits the rotary movement to the drill pipe and bit.

An upper kelly cock is a special valve that can often be recognized as a bulge on the upper part of the kelly. The kelly cock can be closed to shut off well pressure coming up from inside the drill stem.

A lower kelly cock (also called a drill pipe safety valve) is usually made up between the lower end of the kelly and the top joint of drill pipe.

The kelly's upper end is connected to the swivel, and its lower end is connected to the drill pipe. The drill pipe screws onto a device called a kelly saver sub, or a saver sub. The sub is a short, connecting fitting that screws onto the bottom of the kelly.

The kelly fits into a corresponding square or hexagonal opening in a device called a kelly, or drive bushing. The kelly bushing fits into a part of the rotary table called the master, or rotary, bushing. As the master bushing rotates, the kelly rotates; and as the kelly rotates, the drill string and bit rotate.

Rotary drilling derives its name from the rotary table. The rotary table is powered by the compound. The rotary table also accommodates the slips-a tapered device lined with strong, teethlike gripping elements that hold the pipe suspended in the hole when the kelly is disconnected.

## Drill String

The drill string is made up of the drill pipe and special, heavy-walled pipe called drill collars. Each length of drill pipe is about 30 feet long and is called a joint of pipe. Each end of each joint is threaded. The end of the joint with the interior threads is known as the box, and the end of the joint with the exterior threads is called a pin.

## Bits

Two main types of bits have been developed through the years for more efficient drilling. Roller cone, or rock, bits have cone-shaped steel devices called cones that are free to turn as the bit rotates. Bit manufacturers either cut teeth out of the cones or insert very hard tungsten carbide buttons into the cones.

Diamond bits do not have cones, nor do they have teeth. Instead, several diamonds are embedded into the bottom and sides of the bit.

## Circulating System

One of the essentials of rotary drilling is a circulating system. For the rotary drilling system to function, fluid must be circulated downward through the drill stem, around the bit, and upward in the annular space between the drill stem and the wall of the hole or the casing. The principal purposes of circulation fluid are to-

(1) clean the bottom of the hole;
(2) cool the bit;
(3) flush cuttings from the hole;

## STUDENT REFERENCE (continued):

Purposes of circulation fluid (continued):

(4) support the walls of the well so that they do not cave in; and

(5) prevent the entry of formation fluid into the borehole.

### Well Control Equipment

When the subject of well control is mentioned, the first thing to come to mind is a blowout. A blowout is a very undesirable occurrence on any rig, because it endangers the lives of the crew, can destroy a rig worth millions of dollars, wastes much-needed petroleum, and may damage the environment. Although relatively rare, a blowout is an awesome sight. Fluid (either liquid or gas) erupts from the well, usually with great force, and often ignites into a roaring inferno, especially if the fluid is gas. The trouble arises when the pressure in the formation is higher than that in the well. The pressure in the well is maintained by the type and amount of drilling fluid being circulated through it.

The well kicks-that is, formation fluid enters the hole, and some of the drilling mud is forced from the hole. If the crew does not take prompt and proper action at the first indications of a kick, then eventually all of the mud could be spewed out of the hole, allowing the formation fluid to flow uncontrolled to the surface. The result is a blowout.

### Blowout Preventers

Blowout preventers (BOPs), in conjunction with other equipment and techniques, are used to close the well in and allow the crew to control a kick before it becomes a blowout. The two basic types of blowout preventers on a drilling rig are annular preventers and ram preventers. An annular preventer has a rubber sealing element that, when activated, closes tightly around the kelly, drill pipe, or drill collars; or, if no part of the drill stem is in the hole, it closes on the open hole. Ram preventers consist of large, steel valves (the rams) that have sealing elements.

### Safety Provisions and Suggestions

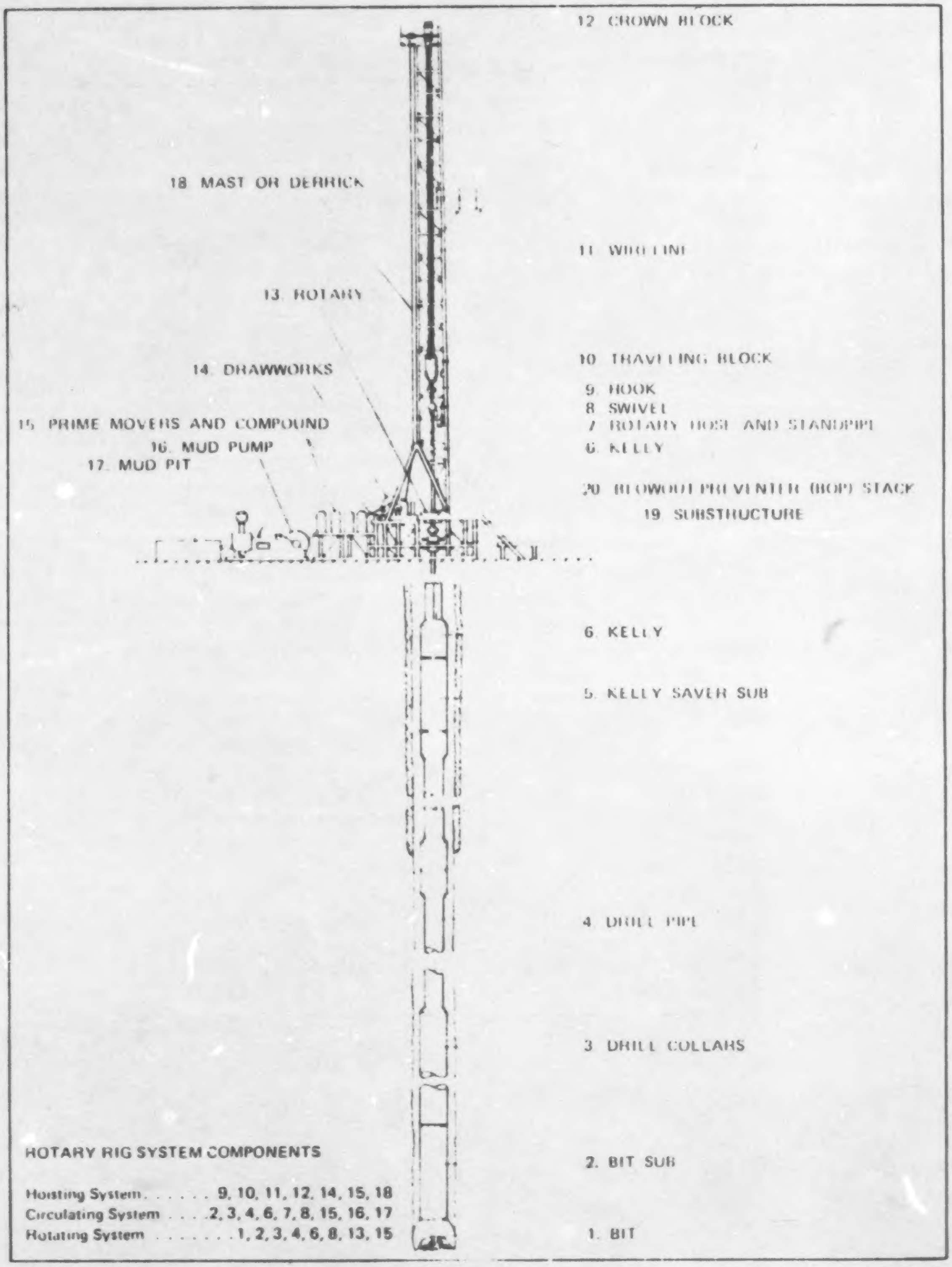
Rig equipment designed to prevent accidents, and fires includes handrails on walkways and stairways, guards on all moving machinery (including belts and chains), and pressure

## STUDENT REFERENCE (continued):

relief devices on mud lines and mud pumps. Safety clothing should, of course, be worn at appropriate times by men working on hazardous assignments or in hazardous locations. Safety clothing includes a hard hat to protect the head from falling objects and safety shoes to protect the feet.

The following safety measures can serve as the beginning of safety measures needed to avoid accidents.

1. Most injuries occur to hands and feet. Fingers should be kept in the clear (out of the way of tongs, spinning chain, etc.), and the proper gloves should be worn. Also, shoes with protective metal caps on the toes should be worn.
2. Improper use of the cathead causes more serious injuries than any other single operation. The new man should use the cathead only under close supervision.
3. Back injuries arise from using an improper stance while lifting a heavy weight. It is important to learn the right way to lift-with the knees, not the back.
4. Tools, grease guns, and other equipment taken up in the derrick should be tied down securely. While these are being used on the derrick, the men on the floor should "stay out from under." No member of the crew should go on the floor unless he is wearing his hard hat.
5. Every rig has safety goggles to prevent eye injuries. Certain operations such as working with chemicals and chemically treated mud should never be undertaken without wearing them.
6. Pipe tongs are safe when treated with respect but can become extremely dangerous if used carelessly. Crew members should check the safety line and stand clear when tongs are used under heavy strain.
7. Pipe wrenches and chain tongs that are prone to slip instead of grip probably need jaws, which should be replaced for safe use.
8. Slippery floors should be avoided. Because drilling mud is slippery, it is especially important for the crew to wash the floor whenever it gets muddy.
9. Loose, floppy clothing that might catch on moving equipment should be avoided.


12. CROWN BLOCK
18. MAST OR DERRICK
11. WIRE LINE
13. ROTARY
10. TRAVELING BLOCK
14. DRAWWORKS
9. HOOK
8. SWIVEL
15. PRIME MOVERS AND COMPOUND
7. ROTARY HOSE AND STANDPIPE
16. MUD PUMP
6. KELLY
17. MUD PIT
20. BLOWOUT PREVENTER (BOP) STACK
19. SUBSTRUCTURE
6. KELLY
5. KELLY SAVER SUB
4. DRILL PIPE
3. DRILL COLLARS
2. BIT SUB
1. BIT

**ROTARY RIG SYSTEM COMPONENTS**

| | |
|---|---|
| Hoisting System | 9, 10, 11, 12, 14, 15, 18 |
| Circulating System | 2, 3, 4, 6, 7, 8, 15, 16, 17 |
| Rotating System | 1, 2, 3, 4, 6, 8, 13, 15 |

STUDENT REFERENCE (continued):

Safety measures (continued):

10. A crew member should take evasive action to avoid injury to himself. He should also always try to avoid injuring another crew member.
11. Handrails should be used when on the steps.
12. Insecure guardrails are worse than none at all, and crew members should be on the lookout for them.
13. The crew member should locate and learn to use such emergency equipment as (1) the first-aid kit to avoid infections; (2) fire extinguishers for small fires that could grow into major fires; and (3) a source of water for washing out the eyes and for washing corrosive chemical from the body.
14. When a crew member is in doubt about an apparently unsafe condition, he should consult the driller.

EVALUATION:

Answer the following questions in writing.

1. Name the three major systems used on all rotary drilling rigs.

2. Name the parts of the drill string that collectively make up the drill stem.

3. What three main functions does the swivel perform?

4. What are the two main purposes of a derrick substructure?

5. The two main purposes of the drawworks are-

6. What are some dangerous effects of a blowout?

7. What causes a blowout?

8. Name the two basic types of blowout preventers and briefly explain how each operates.

## V. DUTY: Equipment Familiarity

### TASK 2: Know and Care for the Bit

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INTRODUCTION:

In this lesson, bit development, types of bits, uses of the bit and the care of the bit will be studied.

LEARNING ACTIVITIES:

1. You will attend the classroom slide presentation of bits after which discussion will follow. A representative of a WV Bit Company will be present to answer questions and students will have the opportunity to examine some sample bits.
2. Read the student reference section and write down 3 questions about the material which you desire more information.

STUDENT REFERENCE:

Formations vary a lot in hardness and abrasiveness and have a big effect on bit performance. If there were no differences in rock formations, the driller could select only one bit, set the bit weight, rotary speed, and pump pressure, and drill ahead at the maximum rate. Sometimes such a situation does exist, but usually the formations consist of alternating layers of soft material, hard rocks, and abrasive sections. Changing the bit every time there is a change in formation is not always practical. Instead, one must choose a bit that represents a compromise, one that performs reasonably well under all conditions it must meet. Choosing such a bit is easier for a well to be drilled in a field where formations are known than for a wildcat in a field where the formations are being met for the first time.

The three types of bits used in rotary drilling (listed in order of their relative importance to the industry rather than their first appearance) are roller cone, diamond, and drag bits.

Roller Cone Bits

The term rock bit means the same thing as roller cone bit. The first roller cone (rock) bit was introduced into

STUDENT REFERENCE (continued):

the oil field in 1909. For the next fifteen years it gradually but steadily gained acceptance, being used primarily in hard formations areas. During this same period drag bits were improved by putting some type of hard metal to the cutting edges and gauge surfaces.

The two cones on early rock bits did not mesh; that is, the teeth of one cone did not fit into the spaces between the teeth on the other cone. So they readily balled up in soft shale because there was no cleaning action by the teeth. When reconditioning was required, roller bits were dressed on the rig floor with new cones and reaming rollers. Also, the drilled watercourses--the passageways drilled through the bit so that drilling fluid could get out-washed out quickly. A replaceable washpipe, which could be renewed when the bit was dressed, solved the problem of washed-out watercourses.

Like other oil field equipment, rock bits underwent constant study and experimentation and were gradually improved. The Hughes Simplex rock bit was redesigned with meshing, teeth for self-cleaning, and a resevoir for lubricant was added in the mid-1920s. The three-cone rock bit was introduced during the 1930s. It featured bearings that were lubricated by drilling mud, and the teeth were designed for various formations ranging from soft to hard and abrasive. These bits appear outwardly to be quite similar to those available today; however, design, metallurgy, and construction have undergone many improvements.

## Design

The designer of rock bits wants heavy-duty bearings, a high-strength cone shell, and full-length cutting teeth. Each feature competes with the others for the limited space avaialble to build the cutting structure on the roller cones. In addition, the designer must balance the toughness of steel against the brittleness of hard-surfacing metarials in determining the matter of long life and effective cutting. As a result, bit designers have developed several types of bits, each of which emphasizes a particular quality needed to drill a particular type of formation.

Bit designers have produced a bit with long, widely spaced teeth on a thin shell with small bearings to be used on soft formations. To overcome balling up of soft-formation bits, they have developed interrupted or deleted gauge-row patterns, so that cuttings, being smaller than the space between teeth, do not get stuck. For medium formations, they have designed teeth somewhat shorter than those for soft formations, yet fairly well spaced. Hard formations require bit teeth shortened even more for added strength; they chip, rather than scrape, the formation.

Designers are also concerned with fluid passageways in the bit. Regular or conventional watercourses were the first to be integrated into a roller cone bit and are still in limited use today. These courses direct the drilling fluid onto the cutters to keep them clean, and the fluid then goes on to clean the hole. The speed of velocity of the stream of drilling fluid in this type of passageway is relatively low, and the disadvantages of the system include balling and cone erosion. Such conventional watercourses have been almost completely replaced by jet watercourses, or nozzles. These nozzles direct the stream of drilling fluid past the cones and completely flush out cuttings in the hole. The stream of drilling fluid can improve the rate of penetration in soft formations by washing away or eroding the formation even before the bit touches the bottom of the hole.

Metallurgical makeup of the bit is another concern that designers must take into account. It is in this area that bit design has made its greatest improvements in recent years. Metals used in making bits have to be tough and heat resistant. Some of the perferred materials used are steel alloys that contain high percentages of nickel and molybdenum. Harder still are steel alloys that contain chrome, carbon, silicon, or cobalt in addition to or in combination with nickel and molybdenum. Tungsten carbide, a very hard metal, is used in granular form for facing cutting surfaces. It is also used to make tungsten carbide inserts that are used as cutting elements (teeth) in some bits.

Finally, designers must consider the relationship among the cones of a roller cone bit, for a change in the shape or size of any cone affects all other cones. Some of the more important design factors involve journal angle, interfit, and gauge surface. The journal angle, or pin angle, is the angle formed by lines perpendicular to the axis of the journal and the axis of the bit. This angle determines the exterior shape of the cones, since each cone must completely fill the allotted space; the larger the angle, the larger the diameter of the cone. Interfit or intermesh is the

the distance the ends of the teeth of one cone extend into the grooves of an adjacent one. Interfit design allows larger cone shapes, which in turn allow increased tooth depth, shell thickness, and space for bearings. It also provides a mechanical means of cleaning the grooves between teeth on the cones, aiding the drilling fluid in keeping the bit clean. The gauge surface of a bit, formed by the heel teeth, determines the diameter of a hole. If the conical angle of the heel teeth is changed, they get out of interfit, permitting more teeth to work the gauge area of the hole and increasing hole diameter.

Rock bits may be classified in general as (1) steel-tooth (milled tooth) bits and (2) tungsten carbide insert bits.

Steel-tooth (milled) bits. Early rock bits were made with two cones that simply rolled wheel-fashion on the bottom of the hole as the bit rotated. These cones were prefectly aligned with each other, in contrast to cones of modern bits. This design is still followed on most hard formation types of bits; in drilling hard formations, the action of the teeth is simply to crush and, to some extent, chip the rock formation in order to make hole.

Modern soft-formation rock bits have their cones offset. The off-center alignment of the cone makes the teeth scrape and gouge the formation as the cone rolls on the bottom of the hole, the amount of scraping depending on the amount of cone offset. Intermeshing of the teeth makes it possible to use longer teeth as well as to include a self-cleaning effect. Bits designed for the softest formations with the least amount of abrasive characteristics have the most cone offset. Reduced offset (or none) is used in bits intended for the hardest, most abrasive formations. In general, widely spaced, long, sharp teeth are used for soft formations, and more closely spaced, shorter, stronger teeth are used for harder rocks. Steel-tooth bits are available for soft, medium, and hard formations, although tungsten carbide insert bits are rapidly replacing hard formation milled bits. Bits that have self-sharpening teeth are also available; on these, one side of the tooth is hardfaced and the other is not, so when the softer side wears away, the hard side still holds a point.

Tungsten carbide insert bits. In recent years, many improvements have been made in sealed-bearing tungsten carbide insert bits. In the past, these bits had only small carbide extensions, adequate for the slow penetration rates being achieved at the time. Carbide insert bits were used to reduce trip time, because the same bit could be used on different formations; however, slow bit speeds reduced the rate of penetration and faster speed could cause insert breakage.

Modern tungsten carbide insert bits run at high rotary speeds-up to 180 revolutions per minute (rpm) or more, as compared to the 45 rpm used with older ones. The new high-speed carbide insert bits also run with much higher weight on bit (WOB) than the older ones, which reduces the expected bit life in terms of hours run.

The really big innovation in carbide insert bits include great durability, good insert burial into the formation-up to 80 percent of the insert per revolution in soft formations-and the ability to drill different types of formations with the same bit. Their disadvantages include the fact that erosion around the base of inserts can result in their loss, and the possibility that with complete insert burial an area of the cone shell can come into contact with the formation and transmit shock loads from the drill string directly to the bearing.

## Diamond Bits

Compared to other bits, a diamond bit is quite expensive. It may cost three or four times as much as a carbide insert bit, just as the latter may cost several times as much as a steel-tooth bit. But the diamond bit, like the various rock bits, is used when it can be demonstrated to offer an economic advantage over others.

Diamond bits have very basic designs and no moving parts, both desirable characteristics.

Watercourses. Watercourses in diamond bits are not variable as they are in jet nozzle bits. They have two basic configurations--cross-pad flow and radial flow. There are also variations of each, as well as combinations of both.

STUDENT REFERENCE (continued):

The cross-pad flow configuration is characterized by alternating high-presssure and low-pressure areas in the bit face. These high and low-pressure areas allow drilling fluid to flow at high velocities across the diamonds to the low-pressure areas. Such action is especially useful for drilling in soft or extremely hard formations or for drilling with oil-base mud.

The radial flow configuration is characterized by drilling fluid flowing from the center of the bit to its outer diameter. Such a flow is quite useful for drilling medium-soft, medium, and medium-hard shales, but is not as good as the cross-pad flow for plastic formations or hard and abrasive sands.

Junk slots are indentations on the sides of the bit matrix that allow large pieces of formation to come out from under the bit and help prevent bit damage. In some bits, the junk slots run all the way up to the watercourses, making it easier to wash the large cuttings out of the way of the bit.

Cones. Diamond bit cones come in a variety of configurations. The three most popular are the double cone, the modified double cone, and the round cone.

The double cone is used chiefly for soft, medium-soft, and medium formations such as shale. This type of bit has the sharp, pointed nose characteristic of bits designed for softer formations. The modified double cone has a broader nose and is used for harder formations. The round cone configuration is used for hard to very hard formations; it usually has a very slow penetration rate but allows a large amount of diamond coverage in the nose area of the bit.

Diamonds. The size and spacing of diamonds on a diamond bit determine its use. Diamonds are classified by number of carats, a measure of weight; the larger the diamond, the more carats it weighs.

Very large, widely spaced diamonds are used for cutting large pieces of soft formations such as soft sand and shale. The diamond size is usually 2 to 5 carats.

Medium spacing of large 1/4- to 1-carat diamonds is used in bits for more versatile use. This type of bit can be used for a wide range of sand, shale, and limestone formations.

STUDENT REFERENCE (continued):

Hard formations call for smaller diamonds-1/8 to 1/4 carat-set in closer patterns. The denser diamond placement produces longer wear in sharp, hard formations such as dolomities and hard shales.

Bits densely set with very small diamonds are used to drill hard formations such as hard limestone; hard, brittle shales; fine, hard sands; quartzite; and basalt.

Sometimes the same bit design can be used with fewer or more diamonds to drill formations of different strength.

## Drag Bits

Although the grandfather of all rotary drag bits-the fishtail-bit has been relegated to the museum of petroleum antiquities, not all drag bits have met the same fate. There are a few areas left where the drag bit has a recognized place in the scheme of things.

The original type of fishtail bit had two blades and aneye for the drilling mud near the threaded shank of the bit. This bit ruled the oil field from the time of Spindletop until the 1920s. During its heyday, every toolpusher was a bit designer and every blacksmith a bit manufacturer. Few drillers were so lacking in imagination that they could not come up with an idea to transform the common fishtail bit into a real hole-maker.

The first man to modify the fishtail by bringing the watercourses through the blade of the bit to an outlet was the inventor of the jet bit prototype. The first actual jet bit, produced in 1947, was also a fishtail drag bit, but it had three or four blades of hard metal welded to the body of the bit. Bits of this type are occasionally used today for drilling soft, shallow formations prior to setting surface casing. They are commonly avaialable in sizes up to 24 inches.

Replaceable-blade bits are made in sizes from 1 7/8 to 16 inches for shot-hole, exploratory, slimhole, blasthole, and water-well drilling. Various sizes of bit bodies can be obtained for the complete range of blade sizes. Blades are expendable and are designed to be completely worn out and thrown away.

STUDENT REFERENCE (continued):

In addition to bits designed for normal drilling operations, there are others specially designed for nonroutine operations.

Special bits called hole openers are used with conventional bits made up below them to open up small-gauge holes. The conventional bit opens up a rathole and the hole opener widens it.

Special diamond bits are avialble that combine pilot bits with reamer pads for opening up undergauge holes to operators's specifications.

Diamond bits have been developed for use with downhole or turbine motors for directional drilling and sidetracking operations. One of the major differences between these bits and conventional ones is the watercourse design. Since better rates of penetration often result from higher levels of hydraulic energy, the watercourses and faces of these bits are specially designed to make optimum use of the reduced amount of hydraulic energy available in such drilling operations. Another factor to be considered in drilling a directional hole is to stability; some of the special diamond bits have built-in stabilizers.

Special-purpose jet bits have also been designed for use in directional drilling. Some of these bits have regular cones with two conventional jets and one enlarged (bit-eye) jet that is directed toward the area where the bit should deviate from a straight hole. The large amount of mud emitted from the enlarged jet washes away the formation in front of the bit, and the bit follows the path of least resistance.

There are special bits available for sidetracking; they are used in conjunction with downhole motors and bent subs. Bits ued for sidetracking have flatter faces than regualr bits, as well as shorter gauges that promote lateral drilling.

EVALUATION:

Answer the following questions in writing.

1. Name three kinds of bits used in rotary drilling.

EVALUATION (continued):

2. The off center alignment of the cones on a modern soft-formation rock bit makes the teeth scrape and gouge the formation as the cone rolls on the the bottom of the hole. This off center alignment of the cone axis from a true radius of the hole bottom is called ______________.

3. Name two types of drilling fluids.

4. Name three things that the drilling fluid is expected to do.

5. Tell when the rock bit, the diamond bit, and the drag bit are used.

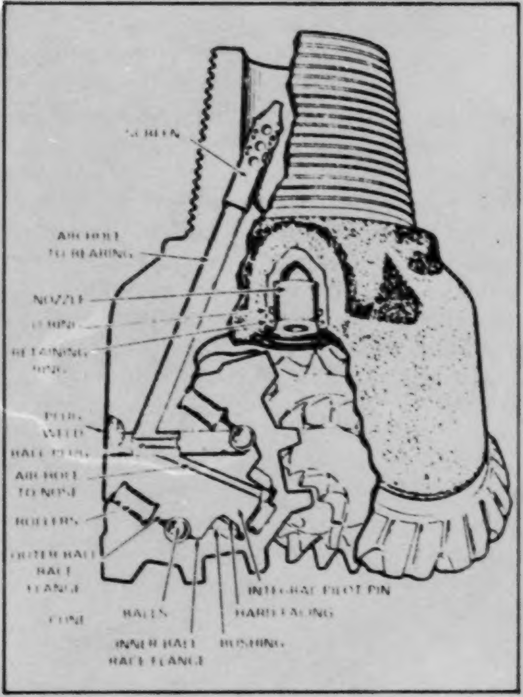
6. List 3 major improvements that have been made in the rock bit.

7. Define intermesh or interfit.

8. Explain how the teeth of a rock bit may differ.

9. What is the journal angle?

10. Give two classifications of rock bits.


SCREEN
AIR HOLE TO BEARING
NOZZLE
O-RING
RETAINING RING
PLUG WELD
BALL PLUG
AIR HOLE TO NOSE
ROLLERS
OUTER BALL RACE FLANGE
CONE
BALLS
INNER BALL RACE FLANGE
BUSHING
HARD FACING
INTEGRAL PILOT PIN

CROSS SECTION OF A JET AIR BIT

V. DUTY: Equipment Familiarity

TASK 3: Define Drill Stem Assembly

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## INTRODUCTION:

The drill stem represents a major investment to the drilling contractor. It is therefore important as a new member of the drilling crew to learn how to handle, inspect, and maintain the equipment correctly and safely. This lesson will teach you what the drill string assembly consists of, how it should be used and cared for.

## LEARNING ACTIVITIES:

1. During a class discussion as you view parts of the drill stem assembly or slides of this equipment, the instructor will discuss what equipment is used and how it should be maintained.
2. Read the student reference section and prepare 3 questions about the material which you do not understand.

## STUDENT REFERENCE:

### Kelly

The kelly is the heavy square, hexagonal, or triangular steel pipe that by engaging the rotary drive bushing by means of the kelly drive bushing, transmits rotating force through the drill string to the bit.

### Design

Kellys measure from 37 to 54 feet, with the 40-feet length being the standard size. Frequently, two pressure safety valves are made up on each end of the kelly. The first, at the top of the kelly, is called the upper kelly cock. The other valve, on the bottom of the kelly, is called the lower kelly cock. One or both of these valves can be closed to keep pressure that may be coming up the drill stem from entering the kelly or the rotary hose.

STUDENT REFERENCE (continued):

Sooner or later, the kelly has to be connected to every joint of drill pipe in the drill string. A lot of wear and tear is produced on the threads located on the pin end of the kelly, which always faces downward. To counteract this, a kelly saver sub should be used. A kelly saver sub, is a piece of pipe with a male (pin) and a female (box) threaded end. This short piece of pipe is screwed onto the sub instead of onto the kelly itself. When the threads on the sub wear out or are damaged, a new sub is made up to the kelly.

Failure

Other than thread damage, three conditions may cause a kelly's removal from service: (1) crooking or bending, (2) fatigue in the drive section, and (3) rounding of the drive corners.

Drill Pipe

Drill pipe is the steel or aluminum tube used to transmit rotational power and drilling fluid to the bit at the bottom of the hole.

Design

Each piece of drill pipe may have an outside diameter (OD) ranging from 2 3/8 to 6 5/8 inches. Drill pipe also comes in standard lengths divided into ranges, as follows:
Range 1 - 18 to 22 feet (obsolete),
Range 2 - 27 to 30 feet, and
Range 3 - 38 to 45 feet.
The most commonly used length is 30 feet. The lengths do not inlcude the length of the tool joint that is attached to each end. A tool joint is a special threaded fitting that is attached to each end of a length of drill pipe to allow it to be connected to others to make up drill string.

Failure

Fatigue is the most common cause of drill pipe failure, often takng place in surface notches such as slip cuts, metal tears caused by the pipe turning in the slips, or deep corrosion pits on the pipe internal diameter (ID).

STUDENT REFERENCE (continued):

Two results of failure are the washout and the twistoff. A washout is a place where a small opening has occurred in the pipe.

Pure Fatigue

The chemical composition, surface finish, and tensile properties of steel in part determines fatigue, or endurance, limit. Pure fatigue is a metal break, with an absence of surface irregularities, that has no visible cause.

Tool Joints

In the history of rotary drilling, many different designs have been developed for threaded joints used to connect lengths of drill pipe. The design of pipe end fittings was modified so that they could screw onto the threaded ends of the drill pipe. These fittings were given the name tool joints because a tightening tool (tongs) was applied at these points to make up or break out the threaded connection.

Design

Drill pipe is identified with a steel die stencil on the pin's taper. Placing the stencil on the box end might allow it to be scoured away by the mating pins or by abrasive drilling fluid.

Care and Handling

It is important to know how to take care of tool joints, since they are greatly abused parts of the drill stem. They receive much of the wear and tear and have to hold up to extreme pressures, rotation, stress, and other downhole forces.

Protectors. Thread protectors help prevent damage to the tool joint. They are available in pressed steel, cast steel, plastic, or rubber. A thread protector is a device that is screwed into the box or onto the pin of a tool joint to keep the threads and shoulders from being damaged while the pipe is moved or stored. A stabbing protector is a piece of equipment, usually constructed of rubber, that fits on the OD of the box of the pipe that is in the hole. The stabbing protector has a funnel-shaped top and serves as a cushion and guide for stabbing pipe.

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STUDENT REFERENCE (continued):

Cleaning. Pin and box threads and shoulders of tool joints should be thoroughly cleaned before the tool joints are added to the drill string cleaning pays off in three ways. First, it removes foreign material, permitting proper makeup. Second, it permits closer and better inspection of the threads. And third, it increases the life of the connections by eliminating abrasive materials.

Lubricating. Threads on tool joints must be lubricated to combat the effects of high torsional loads to which they are subjected during makeup and drilling. Regular grease or oil is broken down or squeezed out of the connections under high torsional loads. Lubricating compounds containing metallic fillers do not squeeze out so easily and will resist additional makeup stresses downhole. Compounds containing from 40 to 60 percent by weight of finely powdered metallic zinc are recommended.

Failure

Wobble. A tool joint is said to wobble if there is any movement between surfaces of the mating box and pin. Wobble can be caused by improperly mated shoulders, low makeup torque, or other conditions. If the joint is allowed to wobble for even a short time, the threads and shoulders of both box and pin are damaged from lapping. If the wobble is allowed to continue, failure, and a subsequent fishing job, may result.

Stabbing. Bad stabbing practices can lead to drill stem failure. When a joint has been cleaned, checked, and lubricated, it is ready to be made up to the rest of the string, and must be handled carefully. Pins have tapered shoulders to aid in stabbing the box, and these may be scratched or flattened by clumsy handling.

Matching shoulders and threads. Using boxes and pins with different-sized shoulders can produce fins, which are thin, sharp ridges around the box or pin shoulders. To ensure that the shoulders and threads of drill collars and tool joints match for a connection, a gauge called a joint identifier can be used. It measures the number of threads per inch and the diameter of the connection.

Makeup. Correct makeup requires the right amount of torque. Too little torque on the joint can cause wobbles, washouts, and leaky connections and allow additional downhole makeup torque. Too much torque can cause the threads on the tool joint to neck down (narrow) by stretching the pin.

Inspection

Required procedures for inspecting tool joints are as follows:

(1) Outside diameter measurement
Outside diameter of the tool joint is measured at a distance of 1 inch from the shoulder, and the classification of the tool joint for minimum OD and makeup torque is determined from the proper API table. In measuring, the minimum shoulder width should be used when there is eccentric wear on the joint.

(2) Shoulder condition
The shoulders are checked for galls, nicks, washes, fins, or any other matter that might affect the pressure-holding capacity of the tool joint stability. The joint is also checked to make sure it has proper bevel diameter.

(3) Joint check
A random check is made on 10 percent of the joints for manufacturer markings and date of tool joint installation to determine if the tool joint has been reworked.

Transportation and Storage of the Drill String

Pipe that is being moved on a truck should be placed with all pins facing the same end. The load of pipe should be snugly chained down to prevent the joints from hitting one another and damaging the tool joints or the pipe itself.

When drill pipe reaches the rig, the truck should be placed so that when the pipe is unloaded, the boxes will face the rig side of the rack. The pipe should be unloaded carefully, making sure that the pipe protectors are on securely. For unloading, a sling and spreader bar for supporting the pipe in two places should be strung from the gin pole. Support in two places is necessary for keeping the pipe under control and preventing it from bending. A snub line should be tied around the load to help control it and keep the pipe parallel to the stack on the truck as it is rolled onto the ramp. The pipe rolling onto the ramp must also be prevented from crashing into the pipe already on the rack.

The first tier of pipe on racks at the drilling site should be at least 12 inches from the ground to ensure good ventilation. Supports properly spaced should be provided to holdup the middle of the pipe and keep it from sagging. Wooden strips of equal thickness should be inserted between layers of pipe over the support areas to keep the weight evenly distributed on the bottom layer of pipe. Ten feet is the maximum recommended height for stacks of drill pipe on the ground, and five tiers are maximum on the rig itself.

## Drill Collars

### Design

Drill collars are heavy, thick-walled steel pipes with threaded connections cut on both ends. Most standard collars are round and approximately 30 feet long; however, they may also be squared or spiraled. Spiraled drill collars are used chiefly in small-diameter holes and directional drilling to prevent differential sticking in the hole. There they provide a passage for the drilling fluid to exit and relieve the pressure differential.

### Functions

A string of drill collars-two or three in some areas or ten times that many in others-performs may tasks.

1. It provides weight to the bit for drillling.
2. It maintains weight to keep the drill string from being subjected to buckling forces.
3. It helps provide the pendulum effect to cause the bit to drill a more nearly vertical hole.
4. It helps support and stabilize the bit so that it will drill new hole aligned with the hole already drilled.

Weight on the bit. The amount of weight required on the bit depends on the kind of formation being drilled, the diameter of the hole, the kind of bit, the tendency of the hole to deviate from vertical, and other variables.

Drill collar weight to the bit may be as little as a few thousand pounds in the case of a small diameter hole being drilled with little weight, to 100,000 pounds or more when a large bit is being used, entailing as few as six collars or as many as forty-eight.

Holding the drill pipe straight. Drill collar weight must be calculated to include enough in reserve so that the drill pipe is never subjected to buckling forces. When drill pipe is subjected to buckling, it bends and becomes subject to increased metal fatigue failure. Furthermore, the body of the drill pipe wears rapidly near the center of the joint and tool joints wear quickly because of abrasion on the wall of the hole.

Providing pendulum effect. Pendulum effect may be defined as the tendency of the drill stem-bit, drill collars, drill pipes, and kelly-to hang in a vertical position due to the force of gravity. The heavier the pendulum, the stronger is its tendency to remain vertical and the greater is the force needed to cause the drill stem to deviate from vertical.

Stabilizing the bit. Large, square drill collars or stabilizers immediately above the bit stabilize the drill stem in the hole and cause the bit to drill a rifle-bore extension of the well in spite of forces that tend to deviate the hole. Packed-hole assemblies using square drill collars or stabilizer guide the bit to drill a true extension of the previously drilled hole. The term packed hole refers to the face that the square drill collars are only about 1/8 inch smaller in diameter than the hole.

Faiures

Drill collar connections are basically the same as the connections on drill pipe tool joints. Drill pipe failures often take place in the body of the pipe rather than in the tool joints, but drill collar failures usually take place in the threaded connections because of cyclic bending stresses, causing fatigue failures.

Inspection

Drill colalrs should be inspected on a regular basis, determined by the type of drilling being done. When it is suspected that drill collars may have served long enough to have fatigue cracks or other damage that may cause failure downhole, special inspection should be made.

## Drill Stem Auxiliaries

Various auxiliary tools are used with the drill stem, including drill stem subs, vibration dampeners, lifting subs, stabilizers, reamers, pipe wipers, and protectors. All should receive proper care and regular inspection.

## Drill Stem Subs

A sub, is a short threaded piece of pipe used to connect parts of the drilling assembly for various reasons.

Kelly saver sub. The kelly saver sub is so called because its use minimizes wear of the threads on the kelly; it is often called the kelly sub. It is attached to the kelly, and into it is screwed the top length of drill pipe.

Other drill stem subs. A crossover sub is used between two sizes or types of threads in the drill stem assembly. A drill collar serves the same purpose but fits between the drill string and the assembly of drill collars. A bit sub serves as an adapter between the drill collars and the drilling bit.

## Vibration Dampeners

Vibration dampeners, sometimes called shock subs, are employed in the drill collar assembly, usually just above the bit, to compensate for the bounce and vibration of a roller cone bit as the cones rotate. Vibration dampeners may contain rubber, springs, compressed gas, or other springing elements for absorbing the bouncing motion of the bit.

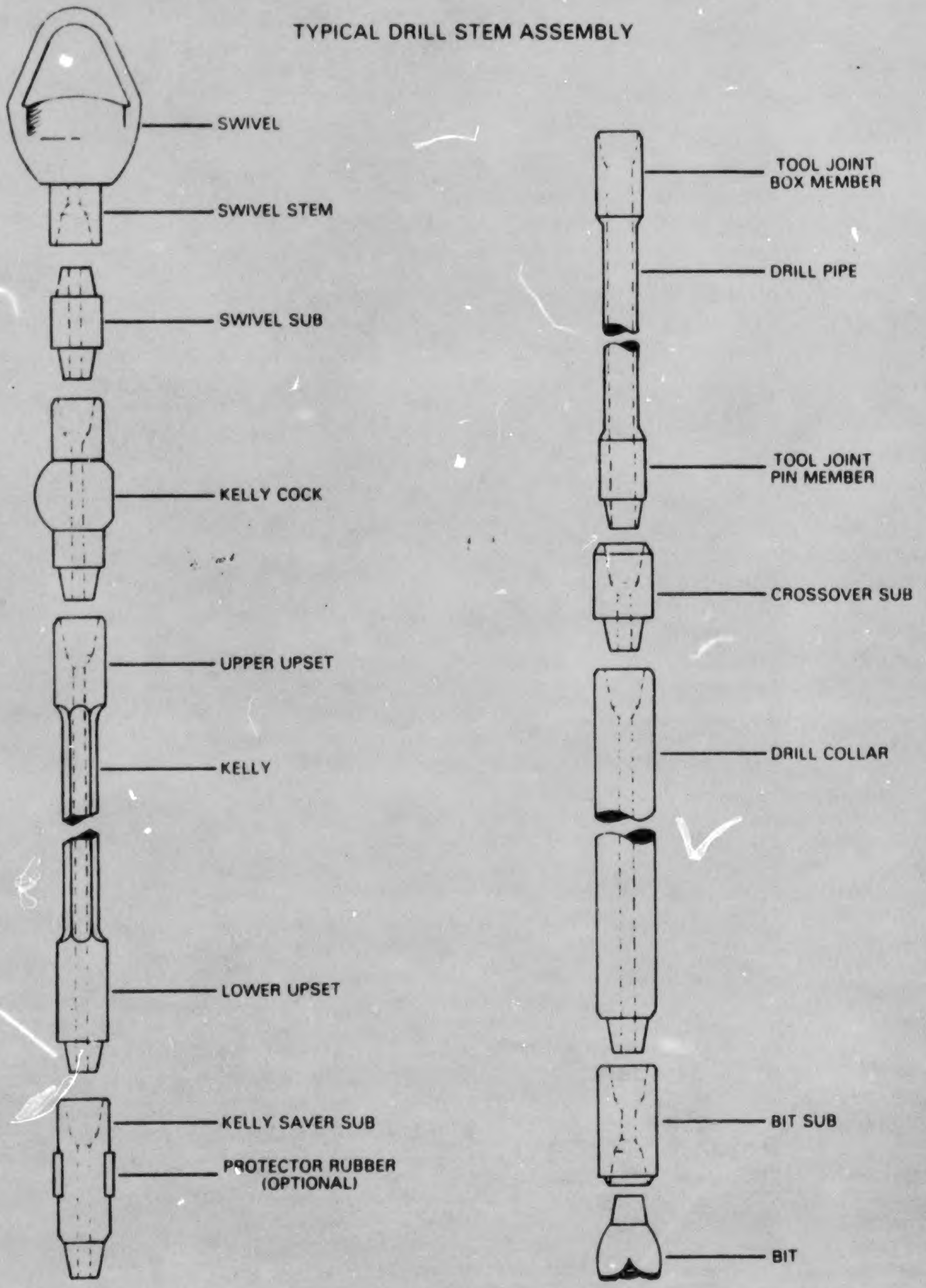
## Stabilizers and Reamers

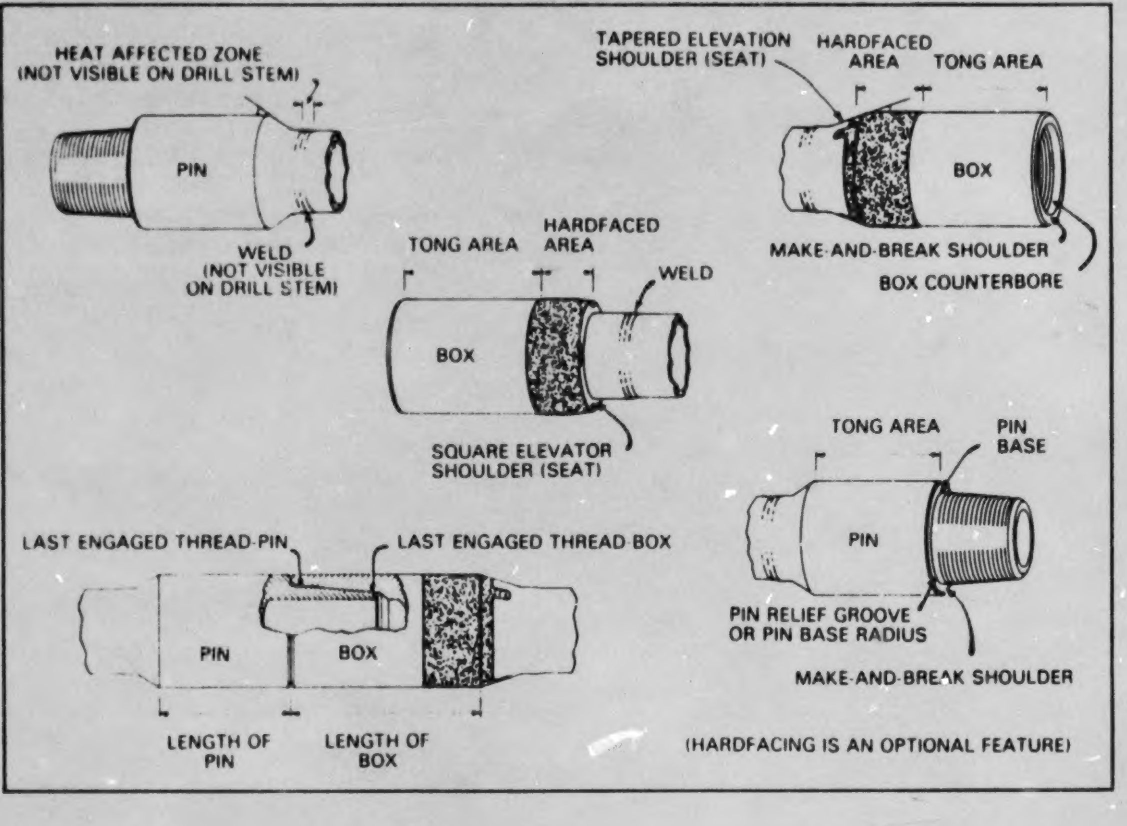
Stabilizers are usually made up in the assembly of drill collars to stabilize the bit and drill collars in the hole. Reamers are used to enlarge an undergauge hole.

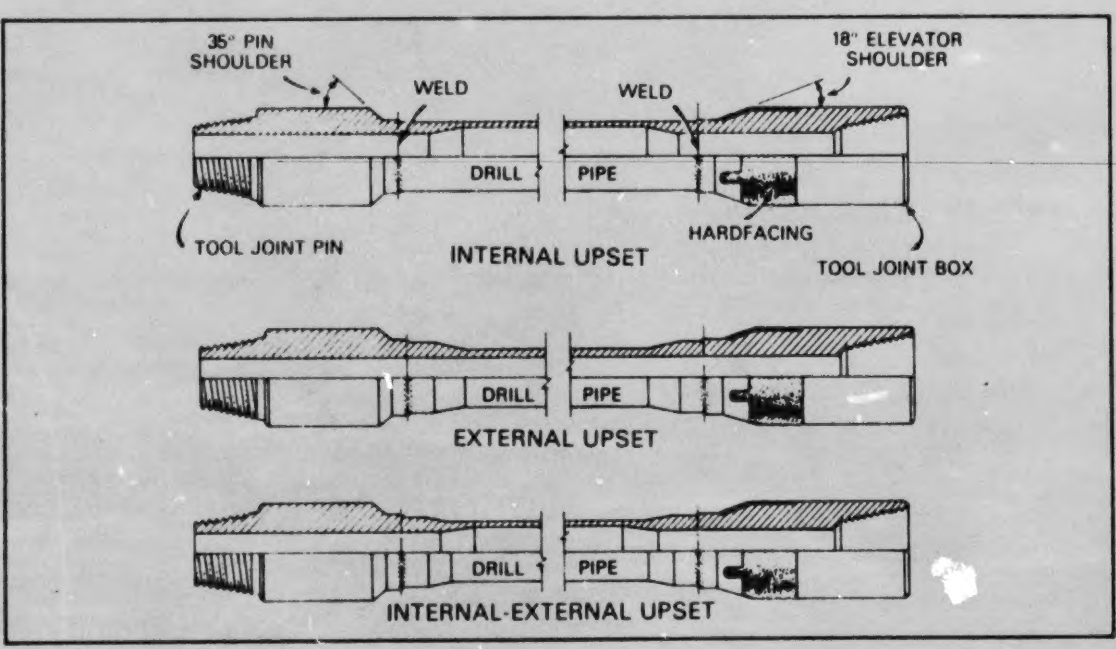
## Protectors

Thread protectors are used on drill pipe and drill collars to protect threads and shoulders from damage. Stabbing protectors guide the stand of drill pipe that is being stabbed to make a connection. They protect tool joint threads and shoulders. Pipe protectors keep tool joints from rubbing against the casing.

## TYPICAL DRILL STEM ASSEMBLY


SWIVEL
SWIVEL STEM
SWIVEL SUB
KELLY COCK
UPPER UPSET
KELLY
LOWER UPSET
KELLY SAVER SUB
PROTECTOR RUBBER (OPTIONAL)
TOOL JOINT BOX MEMBER
DRILL PIPE
TOOL JOINT PIN MEMBER
CROSSOVER SUB
DRILL COLLAR
BIT SUB
BIT


HEAT AFFECTED ZONE
(NOT VISIBLE ON DRILL STEM)
PIN
WELD
(NOT VISIBLE
ON DRILL STEM)
TAPERED ELEVATION
SHOULDER (SEAT)
HARDFACED
AREA
TONG AREA
BOX
MAKE-AND-BREAK SHOULDER
BOX COUNTERBORE
TONG AREA
HARDFACED
AREA
WELD
BOX
SQUARE ELEVATOR
SHOULDER (SEAT)
TONG AREA
PIN
BASE
PIN
PIN RELIEF GROOVE
OR PIN BASE RADIUS
MAKE-AND-BREAK SHOULDER
LAST ENGAGED THREAD-PIN
LAST ENGAGED THREAD-BOX
PIN
BOX
LENGTH OF
PIN
LENGTH OF
BOX
(HARDFACING IS AN OPTIONAL FEATURE)


35° PIN
SHOULDER
WELD
WELD
18° ELEVATOR
SHOULDER
DRILL
PIPE
TOOL JOINT PIN
INTERNAL UPSET
HARDFACING
TOOL JOINT BOX
DRILL
PIPE
EXTERNAL UPSET
DRILL
PIPE
INTERNAL-EXTERNAL UPSET

TOOL JOINT NOMENCLATURE 207

## EVALUATION:

Answer the following questions in writing.

1. What items are included in the drill stem?
2. What is the drill string and what does it do?
3. Why is a kelly saver sub used with the kelly?
4. When is a thread protector used?
5. What is the earliest indication of wobble in a tool joint?
6. List the four tasks performed by a string of drill collars.
7. What is the function of a lifting sub?
8. What is considered the standard size for a kelly?
9. How did tool joints get their name?
10. Explain what will cause the threads on a tool joint to neck down.

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## V. DUTY: Equipment Familiarity

### TASK 4: Working with the Rotary Kelly

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## INTRODUCTION:

In this lesson you will learn about the development, operations, design and use of the kelly, rotary, and kelly bushing.

## LEARNING ACTIVITIES:

1. You will attend a class discussion and slide presentation of the kelly, rotary, and kelly bushing. Exploded views of these rig components will be examined.

2. Read the student reference section and prepare 3 questions about anything you do not understand.

## STUDENT REFERENCE:

The function of the rotary is to rotate and to hold. It turns the drill string and whatever is attached to the end of it. When drilling is going on, the rotary turns to the right, or clockwise, rotary supports the string on slips during intervals when the pipe is not being suspended from the hook. Then it holds.

It supports the suspended string in the hole while the breakout tongs (or other tools) break a tool joint connection with a counterclockwise pull. If spinning tongs are not available, the rotary is turned clockwise to spin out the stand from the string hanging in the rotary. The stand is racked while the rotary continues to support the string in the hole.

When the time comes to run the pipe into the hole, the procedure is similar. The rotary is locked against turning, the spinning chain (or spinning tongs) spins the suspended stand up snug, and the backup tongs, with jerk line and cathead, apply the proper torque on makeup. When the bit is back on bottom, the rotary rotates through a working range of 40 or 50 to 200 revolutions per minute (rpm). As the hole deepens, the kelly descends through the bushings, which are mounted in the table openings.

STUDENT REFERENCE (continued):

Rotaries of the early 1900s were remarkably similar in design to those of the present day. They had the same essential features and could do the same work, though they did it more slowly and with lighter loads. They were of open construction, with moving parts exposed to drilling fluids spilling from above and surging up from underneath. The turntable was prevented from bouncing out of the assembly by four lugs. The drive shaft was mounted in journal-type bearings of antifriction metal. Lubrication consisted of smearing some axle grease on the bevel gears exposed under the perimeter of the turntable. The tops, or working surfaces, were dangerously slippery. Early rotaries, primitive as they were, however, performed well enough for their day.

The only parts exposed on modern rotaries are the protective housings and the sprocket end of the rotary drive shaft. The top of the rotary has a relatively flat, clean work surface with skid-proof footing for the crewmen. Access to the lubrication devices such as grease fittings, oil dipstick and fill plug, and oil reservoir drain plug is recessed into the housing, where damage is not likely to occur.

Rotary manufacturers use either a cast steel base or a reinforced fabricated steel base as a foundation. This provides the strength and stability necessary for such a massive machine. Oil reservoirs for oil-bath lubrication are cast as an integral part of the base. Holes are provided for attaching lifting hooks when the rotary must be handled.

The diameter of the opening through the table for the passage of bits and other tools indicates the general capacity of the rotary. Another size designation is the load capacity of the rotary, which ranges from 100 to 600 tons (t) on large-capacity models.

The drive sprockets on some rotaries are bolted to a hub which is keyed to the pinion shaft. In such a design worn sprockets can be easily replaced. Also, a smaller or larger sprocket can be installed to vary the rpm of the rotary while maintaining a constant speed of the prime mover.

Several different arrangements are used to lock the rotary table. On some models, the table may be locked against counterclockwise rotation (to the left) while reaminig free to turn clockwise (to the right). Others have positive lock against movement in either direction. Still others may be locked selectively against rotation either clockwise or counterclockwise. The locking device is attached to the frame of the rotary, and the locking pin or latch engages the notch or recess on the perimeter of the table or a slot in the skirt. All are protected against accidental operation, and are recessed in the side or the top of the rotary housing.

For convenience in arranging the flooring of the rig, most rotaries are rectangular at the floor level, avoiding the awkward problem of cutting flooring material to fit around a circular table.

Many rotaries are powered by a chain drive from a sprocket on the drawworks, either single-strand or double-strand chain. Some may have shaft drives from the drawworks, although these are not in wide use. Direct-connected prime mover and rotary units have gained acceptance in recent years for several reasons.

1. The driller can exercise more precise control over operations when the rotary has a separate power source.
2. More horsepower becomes available for the mud pumps, improving the general hydraulics situation in deep drilling.
3. The drawworks can be rigged up with more flexibility for the job of hoisting when freed of the demands of the rotary.

With a unitized system, provision is normally made for driving the rotary from the drawworks if power falls on the rotary prime mover.

Maintenance of rotaries consists principally of conscientious, informed lubrication practice. The manufacturers have made this a systematic and simple chore, which should be routine on the rig.

The base of the modern rotary has either one or two oil reservoirs built in. These are to be kept filled to the specified level with clean oil. Keeping the oil clean

## STUDENT REFERENCE (continued):

requires only replacing them when they are no longer serviceable. If the oil becomes contaminated, two steps should be taken: (1) correct the condition that permitted contaminations, and (2) drain and discard the old oil, clean the resevoir of foreign matter, and refill the reservoir with oil of the specified grade. If lubrication of the machine is by oil bath, no action is required except checking the oil level with the dipstick provided and adding oil as needed. Some rotaries are lubricated by a combination of oil bath and grease.

Fittings to supply grease lubrication where it is required will be found either on or near the point needing lubrication, or in a convenient central point on the rotary. In some cases the lubriation panel on the rotary holds a grease fittings, as well as the fill line for the oil reservoir and the dipstick to check oil level.

Rotaries, like many other pieces of drilling equipment, have relief fittings to permit unloading excess lubricant. Crew members should know where these are and should not install other grease fittings there.

Maintenance of a rotary is usually minimal and can be planned in advance and taken care of in the shop when the rig is idle. When a rotary returns from the shop, or when a new rotary is purchased, it must be installed correctly. The procedure is as follows:

1. Check the oil fill in the reservoir. Operate the rotary for a few minutes and then recheck the oil level. Add oil to the specified level.
2. Check the grease-lubricated points to be sure that they have been lubricated before start-up.
3. Be sure that the block hangs over the center of the opening in the rotary. Then make sure that the rotary is firmly fixed in that position.
4. Align the sprocket on the pinion shaft with the sprocket on the drawworks. The sprocket may be moved a few inches on the shaft if necessary before the sprocket key is finally set.
5. Check the tension on the drive chain between the drawworks and the rotary sprocket. In normal operation the lower strand of the rotary drive chain has the load and the upper strand has the slack. With rotary locked and the lower chain pulled taut, there should be enough slack in the upper chain to cause it to drop about 2 to 3 inches out of a straight line at the midpoint between the rotary and drawworks.

## STUDENT REFERENCE (continued):

Installation of rotary (continued):

6. Check the alignment of the rotary sprocket with the sprocket on the drawworks. A straightedge laid against the side of the two sprockets should fit against the side of the sprocket teeth all the way across both.

In addition to the alignment of sprockets and the proper adjustment of the tension of the chain, two other items concerning the chains should be attended to.

1. The guard should be installed before startup. This safety precaution should be a routine matter.
2. Lubrication should be provided for the rotary drive chain. Many contractors use an oil-tight casing that serves as both a chain guard and a device for lubrication. The lower end of this casing (or guard) has a sump at the rotary drive sprocket, which holds oil for an oil bath through which the chain runs continuously. A force-feed system can be developed by having a pressure pump taking oil from the sump and forcing it through a pressure line with outlets directly over the chain. Oil dripping from this perforated pipe falls on the working surfaces of the chain. These surfaces include the roller surface, the inside of the roller, and the crosspins where they move in the side bars of the chain. An inspection door for checking on stoppage of oil flow is required for the casing.

Accessories used with the rotary to carry out its functions of rotating the tools in the hole and supporting the drill string while making connections or trips are (1) the kelly drive bushing, (2) the master bushing and (3) the slips.

The kelly drive bushing is a device that is fitted to the rotary table and through which the kelly passes. It engages the master bushing, which is, in essence, a part of the rotary table. The engagement is accomplished either (1) by drive pins fixed into the bottom of the kelly bushing and fitting into holes bored in the top of the master bushing surface or (2) by a square on the bottom of the kelly drive bushing fitting into the corresponding square recess of the master bushing. The result of this engagement is that when the bushing turns, it turns the kelly bushing, the kelly bushing turns the kelly, and the kelly turns the entire drill string. When the kelly is disconnected from the string and set back, the drive bushing is lifted and set back with it.

The kelly drive bushing is equipped with rollers that permit the kelly to move freely upward or downward either when the rotary is turning or when it is stationary. Since kellys can be square, hexagonal, or triangular, the kelly bushing may be designed to fit either, or it may be designed so that it can accommodate either shape by changing rollers to fit.

Several aspects of maintenance of the kelly drive bushing must concern the floor crew.

1. Lubrication to reduce wear is the most important aspect of maintenance. As a rule, it is done with a grease gun on fittings built into the bushing. It can be done each tour or each day, but must not be neglected.
2. On split-body bushings, it is very important to keep the top nuts tight. They keep the roller pins from working in the body journal areas.
3. The bushing, regardless of its design type, must be inspected regularly for wear. The manufacturer should provide a maintenance and inspection sheet in the IADC format.
4. Inspection may show that certain parts need to be replaced. These parts can be removed and replaced right on the rig floor by the floor crew under the supervision of the driller.

The master bushing is a device that fits into the rotary table and serves as a means for engaging the kelly bushing with the rotary so that torque from the rotary can be applied to the kelly and thus turn the drill string. It also provides the tapered surface to support the slips when holding the pipe.

Master bushings may be constructed in three ways:

1. Split: made in two halves with the taper for the slips machined into them.
2. Solid: made in a single piece with the taper for the slips machined into special bowls, which are interchangeable to accommodate up to 13 3/8-inch tubular goods, using the proper slips.

Master bushings may be constructed in three ways (continued):

3. Hinged: made in two pieces hinged together with large pins. Like the solid type, these bushings have the slip taper machined into interchangable bowls that fit into each half.

In addition to the construction differences, master bushings are divided into two categories based upon the method of drive used in conjunction with the kelly bushing.

1. Square drive. This has a square opening or recess (13 9/16 inches square x 4 inches deep) to accept and drive the square that is on the bottom of the square drive kelly bushing. Two types of square master bushings are (1) the solid master bushing with split bowls and (2) the split master bushing.
2. Pin drive. This has four drive holes that correspond to the four pins on the bottom of the pin drive kelly bushings. Three types of pin drive bushings are (1) the hinged master bushing with split bowls, (2) the split pin drive master bushing and (3) the solid master bushing with split bowls. Three types of insert bowls not only provide the taper for supporting the back of the various sizes of slips but also adapt the master bushing for handling different sizes of drill pipe, drill collars, and casing.

Master bushing accessories include liftig slings for removing and installing master bushing and bowls, and a bit breaker adapter plate to put into the master bushing pin holes for providing a 13 9/16 square recess to accomodate bit breakers.

Slips are wedge-shaped pieces of metal with teeth or other gripping elements. They are used to hold the pipe in place and to prevent it from slipping down into the hole when a connection is being made or broke. Slips fit around the pipe and wedge against the master bushing taper. Rotary slips are used with drill pipe only. Other specialized slips are used for drill collars or casing. The wedging action of the slips in the master bushing serves to change the direction of the downward force of the weight of the string to a lateral or transverse force against the pipe.

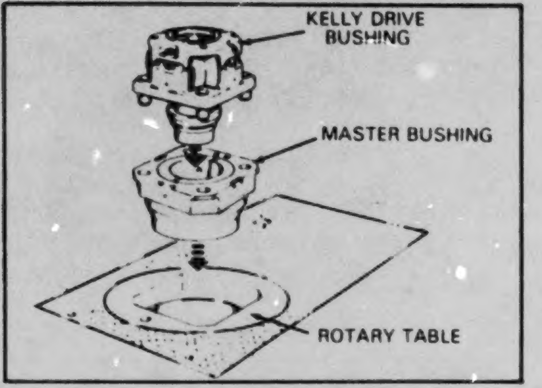
STUDENT REFERENCE (continued):

The basic design of slips consists of body segments hinged together, providing the structural or load-bearing capacity, and a smooth tapered surface bearing against the taper of the master bushing. Gripping of the pipe is accomplished by replaceable elements called inserts, dies, or liners. These elements are designed for specific sizes of pipe and have a radius size number machined on the face. Rotary slips are available in various capacities to accommodate the spectrum of drilling conditions. Drill collar slips and casing slips are also available in various sizes and capacities to suit specific requirements.

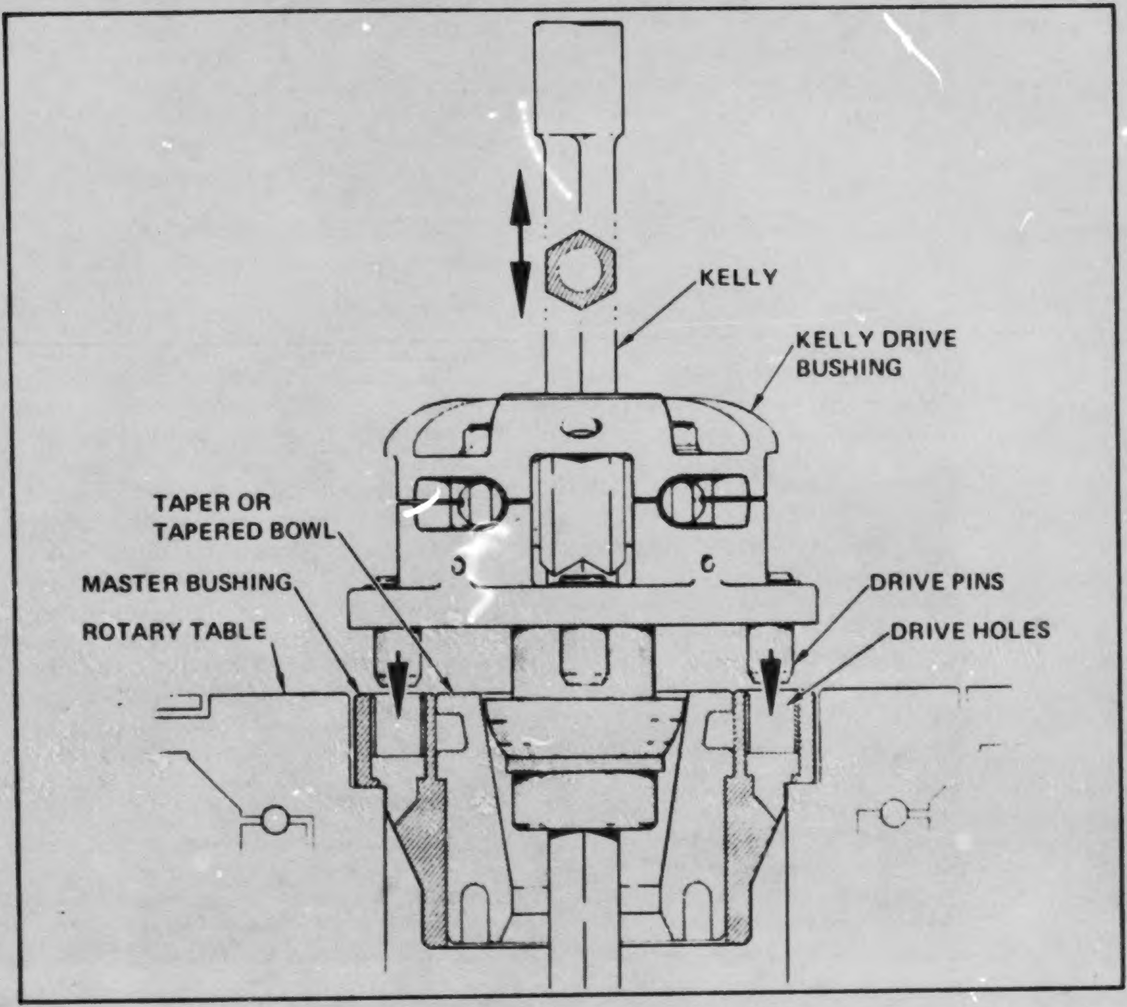
Size of slips used should always be right for the size of pipe being handled. Slips that are smaller than the pipe wil damage the pipe and the corners of the slips, as well as risk dropping the string of pipe. Slips that are too large will not contact the pipe all the way around, risking dropping the pipe and destroying the center part of the slips' gripping surface.

Downward motion of the drill pipe must be stopped with the drawworks brakes, not with the slips! Permanent deformation of the pipe can occur when floor hands are not careful to wait to set the slips until after the driller has stopped the pipe. Furthermore, the crewmen must not allow the slips to ride on the pipe while it is being pulled out of the hole. This practice accelerates the wear on the gripping elements of the slips and also risks having the slips ejected from the master bushing bowl when a tool joint comes through, causing possible injury to personnel. Finally, floor hands must be careful not to catch the tool joint box in the slips when the driller slacks off. Such a happening is likely, when coming out of the hole, if the driller does not pick up high enough for the slips to fall around the pipe properly. Such action can ruin the slips, damage the tool joint box, and damage the body of the pipe. If the driller sets the drill pipe too high, it may undergo some bending.

Spare parts are readily available to repair any part of any slip of recent manufacture. Normally, inserts, dies or liners are the parts that require attention with any degree of frequency, being most subject to wear in normal use. Worn inserts that cause pipe to slip should be replaced immediately. Slippage of pipe through the slips can result in bouncing of the tool joint, kicking the slips out of the master bushing. Such a reaction is dangerous to rig floor personnel and may result in an expensive loss of drill


KELLY DRIVE BUSHING
MASTER BUSHING
ROTARY TABLE

KELLY DRIVE BUSHING, MASTER BUSHING, ROTARY TABLE


KELLY
KELLY DRIVE BUSHING
TAPER OR TAPERED BOWL
MASTER BUSHING
ROTARY TABLE
DRIVE PINS
DRIVE HOLES

ENGAGEMENT OF KELLY DRIVE BUSHING AND MASTER BUSHING

## STUDENT REFERENCE (continued):

string down the hole. Dull or worn inserts and worn slip bodies should be discarded. New inserts carry concentrated load, penetrating the pipe deeply, but resharpened inserts will carry no load; as a result, the inserts carrying the concentrated load are forced into the slip bodies and cause permanent damage. There is no satisfactory way to rebuild, dress, or sharpen these elements and keep them in service after they are worn. Master bushings and bowls must be replaced when worn to maintain proper slip backup. In case a heavy string of pipe is accidentally caught on the slips, the handles, pins, or even the body of the slips may be damaged or broken. Such parts must be inspected and replaced immediately if necessary.

Routine care and maintenance of slips and master bushings will ensure a long life for these components. It will also protect the tubular goods and eliminate the danger of slips sticking and causing further problems. Proper care consists of cleaning and lubricating and replacing worn parts. The slips should be inspected regularly, using a straightedge to detect uneven wear or damage.

## EVALUATION:

Answer the following questions in writing.

1. Name two functions of the rotary.
2. From the pictures provided you will select the rotary.
3. Name two size designations of rotaries.
4. Give three ways the rotary may be powered.
5. What is the principle maintenance requirement of rotaries?
6. The kelly drive bushing is equipped with __________ to permit the kelly to move upward or downward.
7. Give four points to remember in the maintenance of the kelly drive bushing.
8. What is a master bushing?
9. What are slips?
10. Give three steps to be followed in the care of slips.

V. DUTY: Equipment Familiarity

TASK 5: Identify the Blocks and Drilling Line

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## INTRODUCTION:

In this lesson the blocks, their location, care and design will be discussed. The handling, sizing, and care of wire rope and elevators will be covered.

## LEARNING ACTIVITIES:

1. Slides will be presented of the blocks and their location.
2. Wire rope will be displayed and class discussion of how to handle it safely will be attended.
3. Seizing and cutting wire rope will be covered and practiced.
4. Read the student reference section and prepare 3 questions about the material which you do not understand.

## STUDENT REFERENCE:

The drilling line supports the entire drilling assembly by means of pulley-style devices and grasping implements. The pulleys and grasping implements are collectively called the overhead tools. Included among these are the crown block, an arrangement of sheaves (grooved pulleys) that is fixed to beams at the top of the derrick or mast; the traveling block, another sheaved device that moves up and down on the line while pipe is being raised or lowered in the hole; the hook, which is fastened to the traveling block and to which are attached the swivel, kelly, and drill string when making hole; and the elevators, which grip the lengths of pipe for removal when coming out of hole.

The term drilling line designates the wire rope that is spooled onto the drum of the drawworks hoist, reeved (strung) on the crown block and traveling block, anchored at one end, and used to hoist pipe in making a trip and to support the drill string while drilling is in progress. It may also be called the wireline or rotary line, but is not to be confused with the sand line, the swabbing line, or the wireline used on wireline tools.

A block is an assembly of large pulleys known as sheaves mounted on a common framework through which the drilling line is reeved, or strung. Its purpose is to give the drilling line the effect of many lines hoisting the heavy loads required in rotary drilling. The function of sheaves (pronounced "shivs") is to guide and support the drilling line as it passes through the blocks. The number of sheaves in a block is determined by the weight to be supported. It may vary from three to seven; five is most common, but deeper wells often require six or seven. Sheave diameter may be as great as 60 inches.

Sheaves are customarily manufactured of heat-treated manganese steel or special alloy steel. Some are forged in one piece; others are made by applying the grooved rim on a forged web and hub. In most recent-model blocks, the sheaves are mounted in line on antifriction, tapered roller bearings that run on a center pin ranging from 5 to 11 inches in diameter. Lubrication takes place through rifle borings in the center pin by means of grease fittings recessed into one or both ends of the pin. Two features of sheaves are of primary concern. (1) The size or radius of the grooves in which the wireline runs on the sheaves of the traveling block must accommodate wire rope of specific outside diameter; and (2) the tread diameter, the diameter of the sheave measured from groove bottom to groove bottom, is important in considering whether wire rope and sheave will work together well.

If the groove on the sheave is too narrow for the wireline, undue abrasion will occur, both on the rope and on the sides of the sheave. If the groove is too wide, the rope will lack lateral support and will tend to flatten as it passes through the sheave. As the groove wears in use, the dimensions will change until the sheave is no longer serviceable, so the groove radius must be checked regularly.

The tread diameter is important because bending a wireline around a sheave is responsible for a substantial part of the wear on the line. Wirelines in the larger diameters--1 1/2 inches and larger, for example--are not as flexible as the smaller lines. When the large-diameter lines are constantly flexed over sheaves in the blocks, the friction of wire against wire and strand against strand becomes severe. The smaller the sheave (and therefore the sharper the bend in the wireline), the greater is the wear.

STUDENT REFERENCE (continued):

The crown block is an assembly of sheaves mounted on beams at the top of the derrick. Most crown blocks of recent manufacture have from four to seven sheaves, which may be as large as 5 feet in diameter, mounted in line on a common center pin. The exception to this pattern is the crown block for a light-duty portable mast rig, which has sheaves set at right angles to one another and center pins mounted at two different levels. The sheaves on this block, as on most crown assemblies, have restraints to keep the line from jumping the sheave in case slackness occurs. The arrangement of the sheaves causes the fast line and the deadline to go down the back of the mast, contrary to the arrangement of a normal crown block in which the fast line and the deadline occupy separate sides of the derrick. Some crown blocks are equipped with extra sheaves to accommodate a sand line and a catline, the former used for retrieving special tools from the hole and the latter used for hoisting heavy equipment on the rig.

The traveling block moves between an up and a down position on the line. It carriers the hook that supports the drill string when drilling and the elevator bails that hold the elevators when tripping in or out of the hole.

Selecting a block for a certain rig or for a certain job depends on the block's load capacity in tons. The rating of blocks is established by the American Petroleum Institute (API) and may range from 5 tons to 650 tons or more. Blocks can be specially designed to accommodate as much as 2,250 tons.

An additional value is recommended for the load-bearing capacity of the main bearing in the traveling block. Usually the rating of the bearings is higher than the load capacity of the block as a whole.

How the weight of a block is distributed affects its performance. Good design keeps as much of the weight as possible below the center pin. This helps to make the block fall straight when it is not loaded--when coming out of the hole, for example. The tendency of some older blocks to go up in a tilted position, leaning away from the fastline side, can be caused by too much weight above the center pin. Besides attending to weight distribution, all manufacturers recognize the importance of streamlining the block and its housing or guards. They keep the outer surface of the assembly free from parts that stick out and snag on the monkeyboard.

STUDENT REFERENCE (continued):

The hook is a large joining device suspended from the traveling block to grasp the various pieces of equipment needed in drilling and in making trips. It rotates on bearings in its supporting housing and can be locked into as many as twelve different positions. A strong spring within it cushions the weight of the drill pipe so that tool joint threads are not damaged in making up or breaking out the pipe. The hook has a safety latch for the swivel and locking arms or link ears at both sides for the elevator-bail attachments.

Some hooks have special features such as a hydraulic snubber, flexible pin connection, or optional hook positioner. A snubber is a sort of shock absorber that eliminates the bouncing action of pipe. A flexible pin connection between the hook body and the shank eliminates unequal loading on the ears of the elevator or under pipe couplings and tool joints. An optional hook positioner automatically rotates the elevator into the correct position for the derrickman to catch the next stand of pipe when going into the hole and also prevents the hook and elevator from being rotated by the spin-up of pipe going into the hole.

Elevators are clamps that grip a stand, or column, of drill pipe, casing, tubing, or sucker rods so that the stand can be raised from or lowered into the hole. Drill-pipe elevators, used specifically for drill pipe, are attached to the hook by elevator links or bails.

Most of the drill pipe that the elevators have to lift has a taper of 18 degrees on the tool-joint shoulder where it meets the pipe. The elevator that is bored to match the 18-degree taper is referred to in the field as the bottleneck or 18-degree elevator.

Another type of pipe that the crew handles is the type that has a square shoulder on the tool joint box. This tool joint meets the hook at a right angle and therefore takes an elevator that is bored differently from the bottleneck elevator. The collar-lift elevator is used with this type of pipe; the machined surface of the elevator lifts against the square shoulder of the tool joint. This type of elevator is also used with drill collars and slim hole drill pipe that have no shoulders for an elevator to grip. In this case, a lifting nipple or lifting sub must be screwed into the collar or pipe to provide a gripping surface for the elevator. If such a nipple is being used, the driller must be sure to slack off enough when spinning the pipe up so that the nipple will not be backed up.

STUDENT REFERENCE (continued):

Both collar-lift and bottleneck elevators are available in a center-latch variety that opens in the middle and another variety that admits the drill pipe through a small side door. One makes the elevator close when loaded. The hinge pin has a spring that forces the unlatched elevator open.

The new man on the rig may find it hard to distinguish between elevators of different types and sizes. In appearance, the collar and bottleneck elevators are very similar. Their internal shapes are different, however, and one cannot be substituted for the other. Likewise, size differences between elevators may be slight--for example, that between a 4 1/2-inch and a 5-inch elevator. Yet the crewman must be able to distinguish them.

Blocks, hook, and elevators require regular care and inspection to ensure that they will operate properly over a long period of time.

Care of the blocks and hook consists chiefly of one practice; lubrication. The derrickman ususlly lubricates and inspects the blocks and hook, since they are in his work area. The traveling block can be stopped opposite the monkeyboard for this work. Systematic lubrication consists of daily applications of grease to the sheave bearings through the grease fittings provided for that purpose, as well as weekly greasing of bail pins. On blocks not equipped with grease fittings, the alternative procedure suggested by the manufacturer should be followed. The derrickman should make sure that the grease gun he uses is secured at all times to prevent its falling to the floor. The traveling block should be reversed at times to balance the wear on the fastline sheaves, which get the most use. Some blocks have a reversible lubrication arrangement for the convenience of the derrickman. When the block is reversed, the lubrication cartridge can also be reversed, keeping the end with the grease fittings next to the derrickman's work station.

Regular inspection of both blocks involves checking for warped sheaves, worn grooves, loose or bad bearings, and presence of grease fittings, sometimes drop out. The crownsafety platform is checked for damage, along with handrails, crown frame flanges, welds, and beam webs. If possible, the crown block assembly should regularly be reversed to even out wear on the fastline and deadline sheaves.

STUDENT REFERENCE (continued):

Inspection of the hook assembly is directed chiefly toward wear on the line ears. The depth of the link ear should be measured at the point of the greatest wear. The load rating of a hook is reduced by wear on the link ears; for example, the rating of one type of 500-ton hook-block is reduced to 458 tons by 1/2 inch of wear. Any hook showing 1/2 inch of wear should be promptly repaired.

In addition to the inspection and lubrication procedures given for the uncombined block, the hook-block may have an oil level to be maintained. The hook-block hs hydraulic chambers (filled with oil) that serve as snubbers to absorb the tension released when a tool joint is broken out, thereby protecting the main block bearing from shock. The oil level in the chambers should be checked and maintained as recommended by the manufacturer. When the oil is at the proper level, the main bearing remains totally submerged; the oil thus serves as both lubricant and shock absorbers. Its grade should follow manufacturer's recommendations. Seals in the chambers, for retaining the lubricant, must be checked occasionally and replaced when worn. An uncombined hook that has a hydraulic snubber requires the same treatment as the hook-block.

All moving parts of the elevators should be lubricated before each round trip. At the same time they should be examined to determine whether the latch and latch-spring mechanisms are working properly. The hinge pin should be checked for wear that will cause slack in the elevators. When it becomes apparent that the hinge or latch pins are loosening, the elevators should be sent to the factory for a general engineering inspection. The link-block bolts in elevators take a beating and must be replaced at times. The nuts on these bolts should be keyed in place or otherwise made secure and should also be inspected regularly. If the bolt is placed so that the nut end is toward the derrickman's side, then he and the motorman can observe the nut pins when latching and unlatching the elevators during a trip.

Twice a year the drill pipe elevators should receive an inspection performed with calibrated instruments to determine whether wear has significantly changed the dimensions. Collar-type elevators should be checked for squareness, uniformity, and depth of wear. Any surface pitted to an extent greater than 1/16 inch should be reconditioned. The 18-degree taper elevator should probably be checked more often than the collar type. Its degree of taper, or conical bore, should be checked for wear. All tool joints used with the 18-degree elevator should be examined at the same time, since wear occurs on both surfaces. In addition, to the angle of taper, hard banding on the tool joints should be checked to see whether it extends beyond the taper. Banding in this area can wear out the elevator bore rapidly and result in extremely high internal loading.

Elevator links (sometimes called bails) normally outlast most parts of a rig and require no maintenance but should be measured with calipers periodically to determine the degree of wear.

In the making of wire rope, steel wires are made into strands and the strands into rope in an action similar to braiding. Outer strands are laid spirally around a central core.

The inner core supports the outer strands of wire rope and determines its flexibiltiy. Most wire rope used in oil field operations has a core called an independent wire rope center (IWRC). IWRC ropes have greater strength and resistance to crushing than ropers with fiber cores; but rope with a fiber core is less expensive and has more flexibility, so it is often used for swabbing operations. The core of IWRC rope is a strand of steel wires with a spiral that is opposite that of the outer strands. This opposition balances the rope and offsets the tremendous torque put on the rope when it is loaded.

The spiral of strands in a wire rope either to the right or to the left when viewed from above is known as the lay of the rope. Right lay refers to a right direction of the spiral; left lay refers to a left direction of the spiral. Regular lay means that the wires in each strand of the rope are twisted in a direction different from the strands themselves; the opposite twisting strengthens the rope and reduces its tendency to untwist. The visible strands in a regular lay appear to be parallel. Lang lay ropes have both the strands and the wires in each strand spiraling in the same direction. Ropes with a Lang lay are use primarily in industrial applications rather than in the oil field. Around the drilling rig, right regular lay is generally referred to as regular lay.

Lay is also a term used to measure wire rope and signifies the linear distance a wire strand covers in one complete rotation around the rope. This distance is measured in a straight line parallel to the centerline of the rope. If the original lay of a wire rope is known, the rope can be measured for stretching. A stretched rope will have a longer lay than the original measurement, and its outside diameter will be reduced.

Wire rope arrives at the rig on a supply reel, and must be strung up, or reeved, for use. Reeving is the threading of the line from the drawworks drum to the deadline tie-down, passing alternately over a sheave of the crown block and a sheave of the traveling block. The order in which the line is alternated through the blocks is called the reeving pattern. Several variables must be considered in choosing a pattern for reeving a line, and most toolpushers, drillers, and derrickmen have worked out their own systems of reeving.

A new drilling line can be reeved according to several methods. When an old line is being replaced, the new line can be attached to it and pulled through. With no line already reeved, the new line can be attached to the catline for threading the blocks. With a mast-type rig, the line can be reeved with the blocks on the catwalk, before the mast is reeved.

Whether spooling a new line or respooling after a cutoff, the line must go onto the drum under tension so that it will make a tight fit. Slack in the line on the drum cannot be tolerated. This spooling onto the drum of the necessary number of turns before the block is picked up under load is usually accomplished by having the weight of the traveling block, hook, and elevators suspended by a hang-off line (a single length of wire rope to the crown block), as the first turns of the drilling line are spooled onto the drum. If the drum is smooth (rare in modern times, except in sand-line operations), a full layer of line on the drum from one flange to another, with a few extra turns on the second layer, will be required. The first complete layer must be tightly spooled, and the wraps must be so close together that wraps of the next layer will not be able to cut in between wraps of the first layer. If the drum is grooved, ten or even fewer turns on the drum are all that are needed.

STUDENT REFERENCE (continued):

Of all the expendables--that is, items consumed in the drilling of a well--the drilling line is the largest cost item to be paid by the drilling contractor, with the possible exception of fuel and bits. Giving attention to extending the length of its service is therefore of great importance economically. Such attention includes buying the right line, using correct sheave and drum diameters, recording ton-mile service, carrying out a planned program of slipping and cutoff, and maintaining the line with care.

Cutting off a slipped line is necessary when (1) inspection shows definite wear that should be removed, (2) the line has accumulated too thickly on the drum, or (3) the cumulative ton-miles figure since the last cut reaches the predetermined figure for the next cut. In order to cut the line, it is necessary to seize, or wrap, the rope at both sides of the intended cut.

In seizing a wire rope, both sides of the area to be cut are wrapped with wire or metal bands. Tape should never be used in seizing nonpreformed rope. If the rope were to jump or fray while being cut, tape would not hold the strands, and injuries could result. Preformed rope, on the other hand, may be seized with friction tape, since the rope will not fray and the tape will help to avoid flying chips that are the principal hazard in cutting preformed rope.

Seizing can be done by using a wire or by using a metal band manufactured for the purpose. The wire method, preferred by American Petroleum Institute, follows.

1. The seizing wire is wound around the rope several times by hand. The wraps should be kept together, and considerable tension should be kept on the seizing wire.
2. The ends of the wrapping wire are twisted together counterclockwise by hand so that the twisted portion is near the middle of the seizing.
3. Using proper cutters, the twist is tightenend just enough to take up the slack. Tightening the seizing further by twisting is not advisable.
4. The seizing is then tightened by prying the twist away from the axis of the rope with the cutters.
5. The tightening is repeated as often as necessary to secure a finished seizing.
6. The ends of the seizing wire are then cut and taped flat against the body of the rope. After two such seizings are made, the rope is ready to be placed in the cutter.

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STUDENT REFERENCE (continued):

The second method of seizing uses a metal band made for the purpose and is carried out as follows.

1. The rope is laid across the metal band.
2. The band is bent around the rope.
3. The edges are clinched together with pliers.
4. The clinch is made secure by compressing with pliers.
5. The clinch is tapped with the pliers.
6. After two such seizings are made, the cut is made between them.

Two types of wire-rope cutters are in common use: a mechanical type that requires a forceful blow from a sledgehammer and another that works hydraulically.

Cutting wire rope demands strict attention to safety precautions. First of all, the traveling block must be suspended on a hangline before any cutting is done. Secondly, the person cutting the rope must wear safety goggles and gloves. Finally, the person cutting must make certain that the rope is not in a position to spring and injure someone as it is cut.

Although it is desirable to get as many ton-miles of service as possible from the line, the guiding principle in its care is to maintain safe working conditions for the crew by constant vigilance. Proper care of the drilling line focuses on care at the supply reel, minimizing stress, minimizing scrubbing, care of the drum, and lubrication.

When a reel of wire rope is moved from one place to another, protective boards are applied with slings over the wraps of wire to prevent crushing of the line and to protect the line against mud, corrosive water, and wind-borne abrasives. When a crowbar is used to move a reel from which the protective covering has been removed, the crowbar should be applied to the rim of the reel, not to the wire wraps. When a reel is lifted with a hoist, the sling should go through the center hole of the reel and should not be allowed to touch the wire itself. Damage to the reel as a consequence of dropping it can lead to a damaged line; the reel should always be handled with care. It should not be rolled over uneven surfaces where the line may pick up dirt or sand; in fact, the line should never be allowed to drag on the ground. A sturdy stand from which the line can be unreeled should be used. The reel is aligned with the deadline anchor to avoid scrubbing of the line against steel members. Scrubbing against derrick or mast can be prevented by using a large-diameter snatch block. The line should be spooled from the bottom of the reel to the deadline anchor.

Careful drilling practices can minimize stress on the line. Excessive speed is a major cause of line wear and becomes a particular problem when the traveling block is being hoisted. In this situation, the clutch should be thrown out and the block allowed to coast up the last several feet; better drum spooling and improved linewear will result. Another crucial situation occurs when the line is suddenly loaded or unloaded. To some extent, shock loading is unavoidable, but a driller can reduce it by picking up and releasing loads as gently as possible. Release that is too sudden can cause the wire to birdcage; such wire should be removed from service immediately.

Scrubbing wear at the drum is often severe at turnback points next to drum flanges. The line scrubs against the flange and part of the line on the drum. Turnback rollers may be used on each side of the drum to reduce scrubbing at those points where new layers of line are started. When the drum is spooled too loosely, the line cuts in and causes severe scrubbing and crushing in places. Spooling should be done tightly. It should also be aided by using a line guide between the drum and the fastline to reduce vibration and fastline whip.

Proper lubrication will lengthen the service life of wire rope. Wire rope is lubricated as many as three times during manufacturing. First, the individual wires are lubricated as they are laid together in the stranding machine, and then the strands of wire are lubricated as they are closed around the core. Finally, the entire rope may be lubricated before being spooled onto the reel. Although a factory-lubricated rope may never require field lubrication, monthly inspections by the driller are advisable for all ropes.

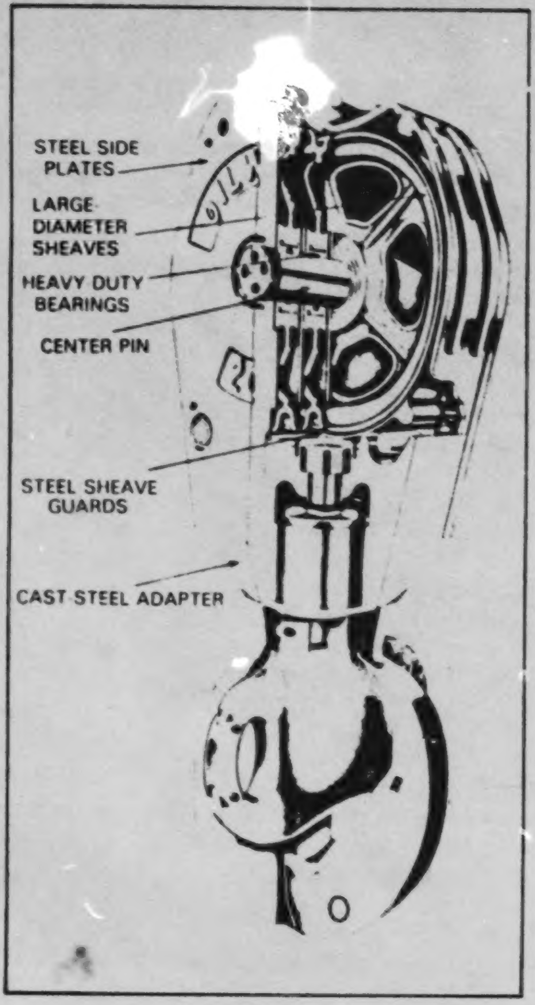
When field lubrication is necessary, a good grade of lubricant that is free from acids and alkalis should be used. The rope should be clean before application of lubricant. Any grit or sand clinging to the rope should be removed with a brush rather than a solvent, which may damage the rope. Several methods of field lubrication are possible. One method is to paint the lubricant on the rope with a brush. Experienced drillers sometimes prefer to lubricate the line during drilling operations. The driller uses a good, clean grade of lubricant. Running the rope through a field bath is a convenient method of lubrication when the rope is being spooled onto a reel for transportation to another rig site. Simple baths can be constructed; the rope is lubricated by being pulled through sheaves inside the bath. Excess oil is wiped off with a rubber cone to protect against cuts.

The drilling line should be given a visual inspection periodically, usually beginning at the drum end as the line is spooled onto the drum. At that end checks are made for broken wires, crushing, and signs of cutting in. The drum can be checked at this time for worn grooves that may become very sharp and shave away small bits of steel from the line, for corrugated grooves, and for irregularities of surface. The bumper on the side of the drawworks can also be checked for possible readjustment. It should be tight enough to turn and start the wraps back, but not tight enough to cause undue pressure on the drawworks cover.

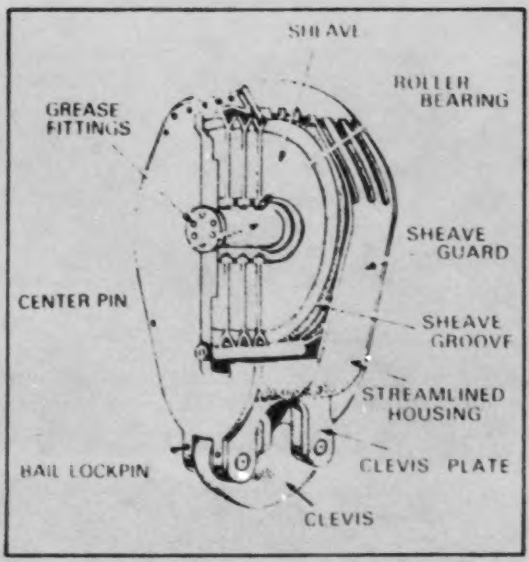
The fastline and other lines as far as the dead sheave are then checked for broken wires and wear at critical points. Broken wires can be caused by fatigue from excessive bending over small sheaves or from reverse bends. They can also be caused by collapse of the rope core due to overloading or excessive rope speeds. Weak places--indicated by broken or worn wires, corrosion, kinks, or distortion of the line--may be removed from the system by slipping and cutting the line.

Checking for evidence of fatigue stress is done at the dead crown sheave and the deadline anchor, where stress is severe because these parts of the line do not move in the continuous process of loading and unloading. Vibration of the deadline is an additional source of fatigue stress. The line at the dead sheave is checked for flatline that touches the sheave groove. The deadline anchor is checked to make sure that the clamps are not tight enough to crush the line, nor loose enough to allow the line to slip through.

A strict schedule of caliper measurement of line diameter should be maintained. Overloading, external and internal corrosion, or excessive abrasion can cause a marked reduction in rope diameter, which is a definite warning sign to remove the rope from service, because its original strength has been reduced. A spot check should be made after any occurrence such as an abnormally rapid acceleration of load, a sudden jerk, or a sudden stop.


STEEL SIDE PLATES
LARGE DIAMETER SHEAVES
HEAVY DUTY BEARINGS
CENTER PIN
STEEL SHEAVE GUARDS
CAST STEEL ADAPTER

HOOK-BLOCK COMBINATION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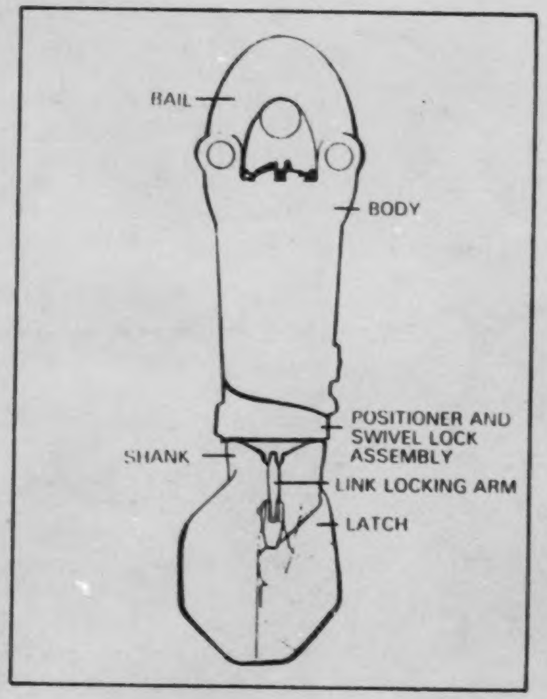
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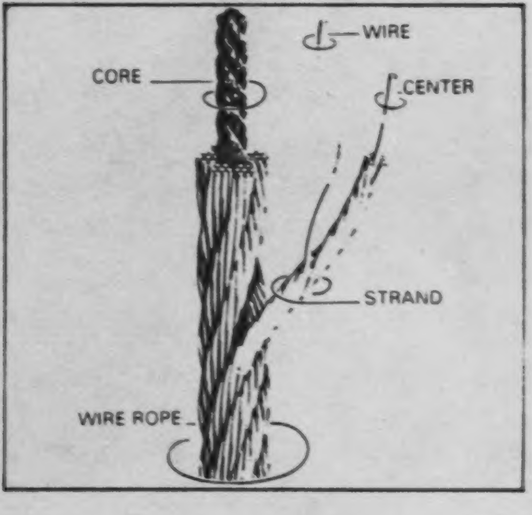
LATCH

MAJOR PARTS OF A HOOK


WIRE
CORE
CENTER
STRAND
WIRE ROPE

CONSTRUCTION OF WIRE ROPE

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## STUDENT REFRENCE (continued):

Such overstressing can cause frayed and broken wires and is particularly apt to happen during fishing operations or working stuck pipe.

When rope is wound onto a drum for moving, it must be checked for tightness, with no gaps or loose winds. Improper winding leads to crushed rope, kinks, and rust.

## EVALUATION:

Answer the following questions in writing.

1. Give the name of two kinds of blocks on the drilling rig.
2. Give the location of the two blocks named in the above question.
3. Why do blocks have sheaves?
4. What is the function of the hook?
5. What are pipe elevators for?
6. What parts of the elevators should be inspected before each trip?
7. What are the critical points on a drilling line?
8. Give four safety precautions to be observed when cutting wire rope.

## V. DUTY: Equipment Familiarity

### TASK 6: Know the Power System on a Drilling Rig

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### INTRODUCTION:

In this lesson the two types of engines which power the drilling rig will be discussed. Maintenance of and safety around the equipment will be covered.

### LEARNING ACTIVITIES:

1. Slides of the power units will be presented and class discussion will be attended.
2. Read and prepare 3 questions about the student reference material provided below.

### STUDENT REFERENCE:

The term "drilling engines" as used in this lesson will cover about 99% of all rotary rig power plants in the drilling industry at this time. Steam power is not an appreciable factor in drilling. It was succeeded by internal combustion engines using natural gas, butane and/or propane for fuels. These continue to carry the bulk of the load. On the increase in the last few years for the super-big rigs have been diesels, with special reference to diesel-electric generating equipment being prominent.

### THE SPARK IGNITION ENGINE

#### Engine Terminology

Immediately following are a number of definitions of terms applicable to the typical gas-fuelled drilling engine: (Most of these terms also have application to diesels)

#### Horsepower

A unit of work established by James Watt in 1870. In order for Watt to sell his steam engines, he found it necessary to state how many horses his engine would be capable of replacing. He undertook this by experiments to determine the power of an average horse. To be on the safe side, and not to overrate his engines, he made his unit of power more than what an average horse is able to exert. Watt defined one horsepower as the ability to do 33,000 ft-lbs of work per minute or 550 ft-lbs of work per second. This is also the power necessary to raise one ton a distance of 16 1/2 feet in one minute, assuming no friction. Note that the definition has an element of time in it.

### "Four Cycle"

In common usage, an engine may be referred to as "four cycle". More correctly the term would be "four stroke cycle". The four strokes required to make a cycle are intake, compression, ignition, and exhaust.

### Natural Gas Fuel

The gas-powered rotary drilling engine may receive its fuel from one of two sources, either directly from the field separators (natural gas) or from LPG (liquified petroleum gas) suppliers. If taken for the field separators, the gas will probably be a mixture of several gases such as methane, ethane, and some propane and butane. In addition, there may be undesriable gases such as those comprised of sulphur compunds. The compounds of propane and butane are on the border line between liquids and gases, that is, they are gases under normal conditions but are readily condensible to liquid under proper conditions of temperature and pressure. The most often used LPG is butane; however, in cold weather propane may be added because it will vaporize at a lower temperture.

Combustion is the process commonly called burning at atmospheric pressures, or explosion in the engine. It is a chemical reaction which produces light, heat, water, carbon monoxide and carbon dioxide. The water is expelled through the exhaust in the form of vapor due to high temperatures involved. For every 1,000 cubic feet of natural gas burned, there are about 12 gallons of water released. Three things are required for combustion to take place: a combustible, oxygen to support the combustion, and some form of ignition such as an electric spark.

### Advantages of Natural Gas

1. Anti-knock rating: Dry natural gas has a very high anti-knock value; and an engine intended exclusively for this fuel may have a relatively high compression ratio and considerable igntion timing advance, both contributing to high efficiency.

## STUDENT REFERENCE (continued):

### Advantages of Natural Gas (continued):

2. Low dilution: Natural gas is ordinarily sold as a "dry gas", free from liquid hydrocarbons. Its combustion is clean; also, lubricating oil dilution and cylinder washing are almost non-existent. Long lubricating oil life, extended periods between oil filter changes, and general engine cleanliness are all normal for gas operation if the gas is dry. With a good grade of gas and a suitable oil, gumming, carbon build-up, and varnish problems are minimal.
3. Storage: Natural gas used on drilling rigs is usually piped in from nearby sources and requires no tank space. Liquid-fuel deterioration problems do not exist.
4. Engine details: Easy starting with low cranking demands, simple carburetion, and less extensive fuel and oil filtering arrangements are required for gas fuels.

### Disadvantages of Natural Gas

1. Inconsistency: All natural gas fuels are not identical. The heat value and the quantities of impurities vary with the location or source. Some natural gas fuels contain high amounts of sulphur although the basic constituent is methane. Field grade gases may require "scrubbing" to remove pipe scale and foreign material. Also some scrubbers are intended to remove the sulphur compunds or other harmful elements by chemcial means.
2. Fire hazard: Any combustible, volatile material presents a fire hazard; gas, being an invisible vapor, under slight pressure can escape unnoticed to form a highly dangerous mixture.

### LPG Fuels

One of the most common fuels on drilling rigs is liquefied petroleum gas (LPG).

This is usually either butane, propane, or a blend of the two. These are stored at the rig as liquids and are converted to gas by release of the pressure on the storage vessel.

Butane vaporizes at about 32 degrees Fahrenheit, while propane changes from liquid to vapor form at about 45 degrees below zero. In cold climates butane would remain in liquid form in the storage tank when the temperature is at or below the freezing point. In order to have a vapor of gas, it is necessary to blend the butane with propane to lower the point of vaporization to about zero. Pure propane might be required when temperatures below zero have to be dealt with.

Both these fuels have quite desirable characteristics for use in drilling engines. They are clean, generally non-corrosive to engine parts, and very responsive to the throttle.

## Gas Fuel Systems

Where field gas is used, a 50-gallon scrubber should be installed to remove scale, rust and dirt. For fuels with a high sulphur content, a commerical neutralizer filter will also remove water and neutralize the undesirable sulphur compounds. LPG systems do not usually need such a filter. A screen filter will do to stop any large particles from entering the engine that may get in the fuel lines between rig moves when the lines are disconnected.

Natural gas brought to the rig through field lines must be under pressure to insure an adequate flow. The flow and pressure in the field lines usually vary. In order to stabilize, regulate, and make this field pressure safe, it is necessary to place a field regulator in the system. The size, type, orifice size and other characteristics of this regulator depend on the characteristics of the gas used, the power output of the engine, engine speed range, and (in some cases) local regulations governing these installations, such as town-lot drilling. Some engine manufacturers prefer to have the field regulator very close to the engine regulator; others may have it remote from the engine with an extra-large line section between to act as a volume tank to reduce any gas surges or lag in the flow resulting from engine acceleration and deceleration. The desired pressure from the field line or field regulator to the engine regulator is 4-6 ounces per square inch for naturally-aspirated engines and 12-15 pounds per square inch for turbo-charged engines.

STUDENT REFERENCE (continued):

LPG fuel systems must have a vaporizer between the high pressure field regulator and the low pressure engine regulator. The high pressure regulator is used in the system because the liquid is stored under pressure. The pressure may vary from zero psi when the weather is -20 degrees Fahrenheit to nearly 200 psi in hot weather.

The final regulation of the gas (either natural gas or LPG) to the engine carburetor must be precise and responsive. The engine regulator is used for natural gas and LPG, except that, the main valve in the regulator is smaller. However, a dual system will allow a change over in fuels without a change in main valves.

As a function of the engine regulator, the amount of gas going to the carburetor is adjusted automatically by the regulator and suction from the engine. The suction, or drop in manifold pressure, is caused by the downward movement of the engine's pistons during the intake stroke, but all of the suction is not directed toward moving fuel from the regulator to the engine; it also brings air into the system at the carburetor. As was stated earlier, the ratio of air to gas must be approximately 18-20 cubic feet of air to 1 cubic foot of gas. Once this ratio is achieved, it remains constant, regardless of speed. An exception is when the engine is choked as it is started. Then the choke butterfly valve is partly closed so that the suction draws in more fuel than normal from the regulator.

Most internal combustion engines breathe in between two and five cubic feet of air per minute per horsepower; therefore, a 600-hp drilling engine will breathe in between 1,200 and 3,000 cubic feet of air per minute, so the air must be plentiful and it must be clean. It is most important that the air cleaner be properly matched to the engine. Failure to do so will result in something less than optimum performance of both the air cleaner and the engine. Most engine manufacturers publish the names of various kinds and types of air cleaners that will operate on their engines. There are two types of air cleaners, the wet type (oil bath) and dry type (paper or fiber element). Both types of cleaners must be serviced frequently.

If a wet-type cleaner is too small for the engine, the relative large volume of air required by the engine causes the cleaner to become quickly overloaded under dusty conditions. Then, there is danger of the dirty oil being pulled from the cleaner into the engine where abrasive material will cause excessive wear or where the oil may cause a "hydraulic lock."

If a dry-type cleaner is too small, it will also "plug up" too quickly under dusty conditions and cause the engine to smoke and lose power to the extent of eventually stalling for lack of air. There is also danger that the operator may discard the filter element because of the short service life and operate the engine without the benefit of clean air. Plugging can occur even with a correctly sized cleaner if it is neglected, so gages or meters are availble to indicate when the cleaner needs servicing.

If a wet-type cleaner is too large for the engine, the efficieny will be lowered and again dirt will be allowed to enter the engine. It will simply be larger and cost more than the correct size. Filters used on turbo-charged engines are larger and must be serviced daily. Any dirt that gets through the filter will build up around the turbine and reduce efficiency, especially if there is oil on the turbo-charger walls.

The carburetor butterfly valve is located between the air-gas mixing point and the engine. It regulates the amount of air-gas mixture going into the engine and is operated by the driller from the driller's console, or by a foot throttle mounted on the rig floor, or both. The linkage between the engine carburetor and driller's console consists of a control air valve at the console, a pneumatic line to the engine, a vernier, a graduated air cylinder or actuator near the carburetor, and mechanical linkage from the air cylinder to the butterfly valve.

## The Ignition System

To ignite the air-gas mixture, the reciprocating gas engine has a timed electrical igntion system. On industrial engines, including the drilling engine, the source of electricity for the ignition system is a magneto. The magneto is a compact combination of generator, ignition coil and distributor. It requires no battery. Voltage is induced within the magneto by the rotating movement of a permanent magnet in a primary coil, or the movement of a coil in the flux field of the magnet.

## DIESEL DRILLING ENGINES

To understand the basic principles of the diesel engine (as contrasted with spark ignition engines) only a few basic considerations need be studied:

1. When air is compressed it becomes hot. This fact is known to anyone who ever used a hand bicycle pump.
2. When air is compressed sufficiently it becomes hot enough to ignite diesel fuel. In the case of the diesel engine, the pressure reaches a figure of more than 500 pounds per square inch (psi) and the temperature will exceed 800 degress Fahrenheit at the top of the compression stroke.
3. The timing mechanism of the engine causes the injection of diesel fuel into the cylinder containing the hot compressed air. The fuel is ignited and causes a controlled explosion.
4. The exploding fuel operates against the face of the piston and drives it back toward the opposite end of the cylinder. This is the power stroke of the diesel.

### Diesel Engine Characteristics

Early models of diesel engines were massive. Their high ratio of weight per horsepower was necessary to provide strength to withstand high compression ratios. They were highly regarded for stationary installation, such as electric power generating stations, power plants for the ocean-going ships, etc. These units are still first choice for diesel electric generators to power drilling rigs on barges and on offshore platforms. In quite recent times they are used more extensively as power sources for heavy rigs on deep drilling jobs inland.

These heavy-duty diesels are relatively low-speed, in the range of 300 to 800 rpm.

The well-known "twins" and "quads" are used extensively as direct driving prime movers on drilling rigs and operate well in excess of 1000 rpm. Diesels used in trucks and buses are designed for more than 2000 rpm.

The ratio of weight to horsepower has been continuously lowered until excess weight is no longer the disadvantage of diesel prime movers that it once was.

## STUDENT REFERENCE (continued):

Perhaps the outstanding advantage of the diesel is its thermal efficiency. That is, it converts to useful power a higher percentage of the energy in its fuel than any other type of engine.

The diesel is available in either two-stroke or four-stroke cycle models. It may also be had with or without supercharged features.

The absence of a spark-ignition system on diesels eliminates the source of most malfunctions in drilling engines. However, the fuel injection system can be the source of many difficulties unless absolute cleanliness is achieved in handling the fuel. The use of top quality diesel fuel (non-corrosive, etc.) is another must.

The fuel is introduced into the cylinder of most diesel drilling engines by the solid injection method, in which a spray nozzle is used. One grain of sand can seriously impede the operation of this operation if it finds its way into the fuel. The spray of fuel produced in solid injection is so fine that it passes readily through the pores of the human skin.

Screens and filters are not only a must in the diesel fuel system; they must be kept clean.

### Diesel Fuel

Gas and diesel engines differ in relation to engine speed and efficiency. Engines are not always run at full power or full speed. The slower the speed at which the gasoline engine is run and the less power used, the less its efficiency. In the diesel engine, however, the efficiency increases as the power output decreases. This is easily explained.

A mixture of fuel and air is compressed in the cylinder of a gas engine, and the ratio of fuel to air must be correct for proper ignition to take place. Too much fuel and too little air, or too little fuel and too much air may not burn. The mixture of fifteen pounds of air to one pound of gas is desirable, no matter how little or how wide the throttle is opened.

In the diesel engine, air alone is compressed by the piston until its temperature is beyond 1,000 degrees Fahrenheit. Diesel oil is then sprayed into the cylinder where it promptly combusts, regardless of the quantity of oil injected. Speed and power are controlled by the amount of oil sprayed into the cylinder. The amount of air is constant and the fuel-to-air ratio is not too important.

If a gas engine runs at one-quarter power, the cylinder is only partly filled with the mixture, but the temperature of the combustion is the same as if it were at full load. A diesel engine runs cooler when delivering one-quarter power than when operating at full load. The amount of air in the cylinder remains the same, and since less fuel is injected at one-quarter load, the air is not made as hot. Consequently, a diesel engine runs cooler than a gas engine under the same load conditions.

The higher heat of the gas makes necessary a more rapid transfer of heat to the cooling water. The diesel engine employs more of its heat to push down the piston. Therefore, a diesel engine is more efficient; less of its heat is wasted.

The efficiency of a gas engine is gauged through its manifold vacuum, because a gas engine requires a specific fuel-to-air ratio. The efficiency of a diesel engine is gauged by the amount of heat given off. The temperature gauge on a diesel engine is called a pyrometer.

Diesel engines are generally designed and rated for fuel classified as Diesel Fuel". Sometimes, because of reasons of economics or supply availability, it may be necessary to run on other fuels such as residual oils. In such cases, the manufacturer of the engine should be consulted. Fuels heavier than #2 diesel fuel, although having more btu's per gallon, may have undesirable characteristics. Sub-standard fuels will affect power, performance and maintenance. Lower fuel costs should be balanced against the overall total operating cost.

For the purpose of general information, the following commonly used terminology is often heard where there is a discussion of fuel oil:

a. "Cetane number" expresses the ignitability of diesel fuel as determined on a comparative basis in a standardized test engine. Diesel fuel requires a definite period of time to ignite after its introduction into the combustion chamber. Low

STUDENT REFERENCE (continued):

a. (continued)
cetane fuels extend the delay period and produce a characteristic knock or roughness in some instances. Higher speed engines naturally have less time available for each combustion cycle, and a fuel which is unable to ignite quickly is unsuited to this type of engine. Most manufacturers specifiy the minimum cetane value recommended in their engines. Failure to observe these recommendations will impair performance and possibly damage th engine.

b. "Excessive water" and "solid contaminants" are extremely serious in diesel fuels and will quickly damage the precision parts of the injection system. All diesels are equipped with fuel filters to the extent deemed necessary for most applications; and in the applications where unusual amounts of free dirt are prevalant, it is anticipated that the specifying engineer will provide additional filtration to compensate. Such material entrained in the fuel as received from the supplier, however, should be held to a practical minimum of about 0.1%. Although the fuels of nearly all reputable refiners will meet this test originally, it is unfortunate that a much greater amount of contaminating material may easily be introduced during the delivery and handling of the fuel.

c. "High sulphur fuels" are seldom a serious problem when the products of reputable refiners within the domestic limits of the United States are specified. Foreign oils, and some domestic oils of unknown sources, may contain enough sulphur to cause definite engine damage. This damage is ordinarily of a corrosive nature. Gum deposits may also be troublesome.

d. Engine manufacturers recommend that limits of "maximum sulphur contents" range from 0.5% to 1.0%. Recent improvements in additive-type lubricating oils have made it possible to tolerate more sulphur than before.

e. "Fuel consumption" in the diesel is based on pounds of fuel used per brake-horsepower-hour. In the gas engine it is based on btu's per brake-horsepower-hour. Actual comparison of fuel consumption between a gas engine and a diesel engine cannot be made except through converting a pound of diesel to btu's, or vice versa. A pound of diesel has a btu content of 19,000. Butane has 21,331 btu's per

e. (continued)
pound and ethane (natural gas) has 22,216 btu's per pound. If each type engine has the same brake horsepower, say 650, the diesel will consume about 5.2 million btu's, while the gas engine will consume 6.5 million btu's per hour. We can then apply the cost of the btu's in each fuel and come up with an approximate operating-cost comparison, which is what most people want to know in the final analysis.

Since diesel fuel remains a liquid until it reaches the combustion chamber in the engine, some method must be devised to transfer the liquid from the storage area to the engine. On rigs having a mechanical compound, the engines are mounted anywhere from truckbed height to 20 feet or more above the ground. Fuel storage is usually at ground level and requires a transfer pump to get the fuel up to the engine. Some diesel fuel systems require a transfer pump to get the fuel up to the engine. Some diesel fuel systems require a return line from the injection pump and injectors back to a storage area. Because the main fuel supply tanks on most drilling rigs are set away from the engine area or drilling area for purposes of safety, it is impractical to return the excess fuel to the main tank. In such cases an auxiliary tank, called a day tank, is provided between the main tank and engine for the purpose of returning the excess fuel to the fuel supply system.

If a day tank is used, it is usually constructed so that baffles prevent the fuel from the return lines and the main tank from rolling and stirring up water and sediment that may be present in the bottom of the tank. The day tank has a drain cock for draining off the water and sediment. The day tank should be mounted low enough in relation to the engine so that excessive filling does not induce a back-flow that may cuase a hyrdraulic lock on top of the piston. Sometimes the main supply tank is built into the engine substructure just below the engines. If this is the case, the return lines may go directly back to the main tank which should also have a provision to prevent rolling the fuel. In either case the tanks are vented, yet protected from entrance of dirt, sand, trash and drilling mud.

In some installations, it may be found that the return line is hooked directly into the injection pump for recirculation, but this is not recommended because it may introduce vapors into the injector line.

STUDENT REFERENCE (continued):

A well-designed diesel fuel system will have lines at least one size larger than the minimum size calculated to carry a given volume of fuel. Top-quality lines and fittings are used to prevent air entering the system.

The slightest amount of dirt in the engine fuel is objectionable. The filters and strainers are available in a wide range if sizes and types. The strainer-type units are intended only for the removal of the coarsest scale and foreign matter. First and secondary filters with replaceable elements remove most of the remaining material, but the small, micron-size particles may be even more damaging. The final filters used to protect against these small particles are often sealed and replaced as a unit.

Most diesel engine manufacturers supply a fuel transfer pump and hand primer with the engine to supply the injector pumps with fuel, since some injector pumps have no suction power. The transfer pump operates while the engine is running, but a simple hand primer is used when the engine is being started. The transfer pump may be any type of pump, such as a centrifugal, diaphragm, gear, or the simple plunger-type pump.

The fuel, when it goes into the diesel combustion chamber, must be injected against the pressure of the compressed air (which is usually in excess of 500 psi). The injected fuel must go into the combustion chamber with such force that is atomizes and mixes thoroughly throughout the chamber. This means that somewhere in the fuel system there must be a high-pressure pump.

The unit-injector system has a low-pressure pump to get the fuel up to the injectors. Incorporated in each injector is a single-plunger high-pressure pump which meters the fluid through the spray nozzle into the combustion chamber.

The main working parts of the injector are: rack, gear, plunger, follower, spring and spherical check valve.

This system has no central metering or pressure pump; hence, it has no high-pressure lines that could rupture. The injectors may be easily replaced since they are slipped into a tapered hole in the center of the cylinder head and are held in place by a dowel and an injector hold-down crab and nut. The system is self-bleeding of any air. Unit-injector systems may provide 5,000 psi or more injection pressure without penalties. The higher pressures give better penetration and a more thorough atomization of fuel into the combustion chamber. As a result, plain combustion chambers may be used.

In a multi-pump system high-pressure pumps operate similarly to the single injection units but are built into a single housing attached to the side of the engine and are activated by a timing gear off the engine crankshaft. In the housing is a pump for each cylinder which also meters the fuel and sends it through a high-pressure line to the cylinder. In each combustion chamber there is a simple spray nozzle.

Multi-pump systems are quite popular. The chief objection to them is that high-pressure fuel lines between the pump assembly and injectors may rupture. Also, servicing is difficult because the pump assembly contains a number of individual pumps. When a breakdown occurs, the practice is to exchange the whole pump assembly, which also incorporates the governor. The system is not self-bleeding; and as a result, whenever it is disassembled, lines must be bled of air.

Most engines using this system use precombustion or turbulence chambers to assure adequate mixing of air and fuel because the nozzles have only one opening through which the fuel passes into the cylinder. A precombustion or turbulence chamber also requires a piston-head design that will insure even burning of the fuel.

The distributor-type system is much like the multi-pump system except that it uses a single pump and a rotating channel to distribute high pressure through individual high-pressure links to the nozzle in each combustion chamber. Like the multi-pump system it is mounted on the side of the engine and is driven off the engine crankshaft. The single fuel-transfer pump has a single plunger (or opposed plungers) that may be either high or low pressure. Fuel oil is distributed to each cylinder in proper firing order by a rotating device with a hole or slot made to line up with the proper fuel line.

The nozzles used with the distributor system are similar to those used in multi-pump systems. Pressurized fuel in both cases is furnished by the engine-mounted pump assembly and carried by high-pressure fuel lines to each nozzle.

STUDENT REFERENCE (continued):

Long fuel lines such as used in multi-pump and distributor systems could detract from the accuracy of the timing of each fuel injection. The length of each high-pressure line must be the same so that the timed surge will not arrive at one cylinder earlier than another.

There is a fourth system called the common-rail or pressure-time system, but it is not popular on drilling engines because it is best suited for a constant-load operation. It is not suited well for applications where the speed must be changed continually, nor for high-speed use.

Repair of the diesel fuel system should be left up to service or shop personnel.

The driller's throttle control is set up similar to the controls for the gas engine; but instead of operating a butterfly valve, it varies the effective stroke of the injector plunger and re-adjusts the governor. The diesel governor is either built into the injector pump or is attached to the plunger through mechanical linkages. In either case the driller's throttle is attached to external levers on the governor so that the driller can increase or decrease the engine speed. Once the driller has selected the engine speed he wants, the governor controls the injector pump mechanism so that the engine will maintain proper rpm, even with varying load, up to its maximum horsepower.

## LUBRICATION OF DRILLING ENGINES

If you are not thoroughly familiar with the lubrication of the engines on the rig where you work - and this includes the lubricants - you should nag at someone until you get a manufacturer's manual covering the subject. The contents of this lesson will not make an acceptable substitute for such a manual. However, the following pointers will be useful.

### Oil in the Crank Case

A key point in lubrication of an engine is the oil in the crank case. First, second, and third: It should be clean. This means it is kept clean on the rig and the filters which keep it clean in the engine are changed as required. The right amount of the right kind of oil is added at change time. More may be added as the oil level drops in use.

## Oil System Accessories

Oil filters have been mentioned as an important part of the oil system. These are changed or cleaned periodically, usually when the oil is changed. The filter to be installed should follow manufacturer's recommendations. Your employer probably has standardized on the type to be used on your rig. In making the installation, the correct connections should be used (there have been cases of filters being installed backwards), and the new filter should be checked for possible leakage after operations are resumed.

## Crank Case Ventilation

While ventilation of the crank case is not, strictly speaking, a part of the lubrication problem, good ventilation will prolong the useful life of the engine oil.

There is the possibility of a breather cap becoming clogged. These should be washed when the oil is changed, or more often if needed.

## Miscellaneous Grease Points

In addition to crank case oil and the lubricating job done by it, the drilling engine has a number of points to be lubricated with the grease gun. (ONLY when the engine is shut down). These points include such items as the water pump, the radiator fan and in some cases magnetos, etc. In some cases lubricating oil may be used rather than grease.

## High-Temperature Control

On some engines there is s shutdown device which operates and stops the engine when the lubricating oil runs too hot.

Another accessory found on some engines is an oil cooler. This is a form of heat exchanger where the oil is circulated through heat exchanger tubes while cooling water circulates in the shell around the tube bundle.

## ENGINE COOLING SYSTEMS

In this section our concern is with the function of the cooling system.

STUDENT REFERENCE (continued):

Heat is generated in the cylinders of the engine. It is removed by coolant (usually water) which circulates around the cylinders. Heat is also generated in torque converters. This heat is removed from the oil of the converter as it passes through a heat exchanger. The heat is transferred to the engine coolant. The crank case oil of the engine also may be cooled through another heat exchanger, with the heat being picked up by the engine coolant.

With the exception of certain marine operations which will be discussed later, the heat in the engine coolant must be dissipated so that the relatively cool engine water may be recirculated to pick up more heat and take it away.

## Radiator and Fan

Cooling the engine water takes place, typically, in the engine radiator core, through which an induced draft of air is continually passing. The draft is created by the engine radiator fan.

The fan, like the pump which circualtes the coolant, is driven by power from the main shaft near the front of the engine. This is the typical automotive arrangement which is practically standard on conventional land based drilling rigs. The system is hard to beat if the water is plentiful and pure. Generally it is not pure.

When hard water - that is, water with minerals in solution - impinges on a hot surface it deposits a scale. This happens on engine water jackets and in the cores of radiators. The more scale deposited the less effective the cooling system.

This calls for chemically treated water which is seldom completely satisfactory. However, chemically pure water used a a coolant in a closed system is the best answer now known. Chemcial flushing of the water passages in the engine radiator is helpful if lost time on the rig and the cost of the treatment are not excessive.

## Thermostats

Ordinarily thermostats will seldom need replacement in the field; they should, however, be checked from time to time. Thermostats in apparently good condition should be test[illegible] in hot water for proper opening. A bucket or other container should be filled with sufficient water to cover the thermostats and fitted with a reliable thermometer suspended in the water. The thermostats should also be suspended in the water to prevent the sersitive bulb or bellows portion from resting directly on the bottom of the bucket or from touching the side. A stove or torch can be used to bring the water to a heat range of 160 degrees Fahrenheit while the thermostats should start to open and should be completely open when the temperature has reached 185-190 degrees Fahrenheit. Lifting the thermostat into the colder, surrounding air should cause a pronounced closing action, and the unit should close entirely within a short period of time. Use care in reseating the thermostats in the engines in order to avoid interference with thermostatic action.

## Engine Exhausts

There are a few features relating to exhaust stacks which the new man will want to notice.

1. The exhaust is supported independent of the engine.
2. There is a flexible connection in the exhaust line to mitigate the effects of vibration.
3. A spray nozzle designed to create a "fog" in the exhaust line is installed to prevent fires. This feature deserves more than passing notice. When the air about the rig is filled with gas (as during a drill stem test) a flash from the exhaust could start a fire of the type that has destroyed many a rig. The spray is designed to prevet this and it is an easy thing to neglect to turn it on.
4. The exhaust line is so arranged that rain cannot fall into it.

## Starters

Energy needed to "crank up" the big engines is supplied in one of two ways:

1. Compressed air from an air storage vessel which is found on most rigs. The air is delivered to the air starter which in turn starts the engine. The starter engages and disengages automatically.

STUDENT REFERENCE (continued):

Energy needed to "crank up" the big engines is supplied in one of two ways (continued):

2. A starting engine in the range of 10 hp and up. The starting engine may have an electric starter to kick it off, or it may start with a pull rope after the fashion of the lawn mower or the small outboard motor. It is engaged to the engine by means of a power take-off device which is manually engaged and disengaged.

It should be noted that starting one drilling engine by use of another operating through the compound is discouraged by mechanics.

It goes without saying that the starting engine should receive normal maintenance attention, since it has to do its job before the rig engines can be put into service. A balky starting engine can be a frustrating thing.

### Emergency Shut-Down Devices

There are a number of conditions which, if they arise on a rig and go unattended, can do a great deal of damage. Each of these has been the basis for the design of an emergency shut-down device to prevent such damage:

1. Engine over speed
2. High radiator temperature
3. High oil temperature
4. Low oil level

## EVALUATION:

Answer the following questions in writing.

1. What are the two general types of engines used on a drilling rig?

2. What three things are necessary for combustion to take place?

3. Name the three main products formed by the chemical reaction of combustion.

4. Name two of the three systems used for fuel injection in diesel engines.

EVALUATION (continued):

5. Name two conditions that will usually cause an engine to make an emergency shut down.

6. What type of fluid is used in the torque converter?

7. Why does the fluid in the torque converter not get hot?

8. What is the definition of horsepower?

## V. DUTY: Equipment Familiarity

### TASK 7: Explain the General Arrangement & Principle Purpose of Circulation Equipment

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## INTRODUCTION:

In this lesson you will learn the components, general arrangement, and functions of the circulation system on the rotary rig.

## LEARNING ACTIVITIES:

1. Attend a class discussion covering the material in the reading assignment.
2. View slides of a typical circulating system of a rotary drilling rig used in West Virginia; as a class locate and identify the parts of the circulatory system as seen in the slides.
3. Read and prepare 3 questions about the student reference section.

## STUDENT REFERENCE:

Two things make drilling with a rotary rig distinctive. One is the fact that the drill stem is turned, or rotated, in order to turn the bit. The other is the fact that some type of drilling fluid (either a gas or a liquid) must be circulated--that is, pumped down the drill stem, out of the bit, and back up the hole to the surface. Circulation of a drilling fluid is the only way in which the cuttings that are made by the bit as it drills through the underground formations can be swept out of the way and brought to the surface.

Other purposes of the drilling fluid are to permit the detection of gas, oil, or water that may enter the drilling fluid from a formation being drilled and to transmit power to the bit.

More than 98 percent of all wells drilled by the rotary methods employ water alone or water-based mud as the circulating fluid. Air or gas is used in less than 1 percent of the wells drilled. Air or gas drilling has several advantages, among them speed of drilling, but water entry into the hole limits its use to a relatively few areas.

Compressors must be added when circulating air or gas. When using high-pressure gas, the gas must be connected to a the regular equipment used for fluid circulation by means of meter and regulators. Usually a well is started with water or mud as the circulating medium, and a string of casing is set before beginning to drill with air or gas. Because a water-producing zone may be encountered at any time, preparations should be made to circulate the fluid encountered out of the well. To do so, air or gas is injected at the standpipe through the drill string to the bit, from whence it flows to the surface. At the surface it is turned to waste through a line leadling from the wellhead. The hazard of fire is considerable on an air-drilled hole, and everyone on the job must be alert to the danger at all times.

The main components of a system for circulating fluids in rotary drilling include a (1) mud pump, (2) flexible hose, (3) swivel, (4) drill stem, (5) bit, (6) annulus (return passageway), and (7) mud pits. (The fluid is picked up again by the pump in the mud pits.) Pit arrangements may be very simple for circulating water or elaborate with many auxiliaries for handling heavy mud.

## PURPOSES OF CIRCULATING FLUID

### To Clean the Bottom of the Hole

A rotary bit must have a clean surface on which to work when making hole, regardless of whether it is crushing or shearing the formation. If the chips or cuttings are not swept away as they are formed, the bit bogs down and eventually the drill stem cannot be turned. For the bit to regrind the chips already broken off from the hole bottom is to waste its effort, reducing the power available for making hole. The usual method of cleaning the bottom is by fluid circulation through jet nozzles in the bit. High-velocity streams of fluid blast the bottom of the hole, creating a turbulence that moves the chips from the face of the formation as fast as they are formed. For drilling with air or gas, the pressure and volume applied to bring the cuttings to the surface are normally more than enough to clean the bottom.

## To Cool the Bit and Lubricate the Drill Stem

The bit is pressed against the bottom of the hole very heavily. For example, drilling weight on an 8 1/2 inc. (215.9-mm) bit sometimes exceeds 60,000 pounds (lb), or 27,000 kilograms (kg), which is about the weight of a railroad freight car. A large-diameter bit might require double that amount of weight. The bit may be rotated at a speed of 50 to 100 revolutions per minute (rpm). This combination of weight and speed creates heat due to friction in the bit bearings and the abrasion of the formation against the teeth or blades. Unless a bit is properly cooled, it overheats and quickly wears out. Air or gas circulation is particulary efficient for cooling because the air or gas expands as it leaves the nozzles of a bit, causing a cooling effect. For this reason and because air contains no significant foreign material, wear on the bit bearings is much less with this method than with mud circulation.

## To Transport the Cuttings to the Surface

The liquid, air, or gas circulated moves rock chips, sand, or shale particles out of a well as it moves up the annulus. for a liquid, the annular velocity, or speed, should be from 100 to 200 feet per minute (ft/min.), or from 0.5 to 1 meter per second (m/d), in order to keep the hole clean. Circulation of 3,000 ft/min. (15 m/s) is considered ample velocity in the annulus for cleaning with gas or air.

## To Support the Walls of the Well

A drilling fluid with the proper characteristics can support a formation that might otherwise cave into a well. This type of drilling fluid, or mud, plasters the walls of a well like a mortar. Also the hydrostatic presssure created by the weight of the fluid column in the hole pushes against the plastered wall to support unconsolidated or loose formations that might tend to fall or slough into the well.. Hard-rock formations usually do not have this tendency to slough and therefore can be drilled with air, gas, or water instead of mud.

### To Prevent Entry of Formation Fluids Into the Well

The pressures of gas, oil, or water in formations penetrated by the bit may exceed the hydrostatic pressure of the fluid column in a well. If this happens, formation fluid enters the well unless back pressure is held on the column at the surface or heavier mud is circulated in order to obtain enough pressure at the bottom of the hole to overcome the formation pressure. Air is a very good circulating medium except for its inability to overcome formation pressure; a column of air obviously will not hold back much formation pressure. However, water entry into the well is the main reason that air drilling is not used more often.

The special valves and fittings at the wellhead, which are called blowout preventers, are for emergency control when formation fluids enter the hole. They are used to control the pressure to be circulated. Maintaining the characteristics are the best ways to prevent blowouts. Although this lesson does not deal with the technique of killing a threatened blowout, the new man on the rig should know the signs of a blowout is an increase in the volume of fluid returning from the hole. Also, when a blowout is about to occur, mud continues to flow from the well when the pump is shut down, and a volume gain in the mud pits is observed.

## CIRCULATING WITH AIR OR GAS

Whenever it is possible to circulate with air or gas, the rate of drilling is faster than when a liquid must be used. Penetration rates are higher, footage per bit is greater, and bit cost is lower with air or gas. Air or gas cleans the bottom of the hole more effectively than mud, air expansion at the bit is very efficient for cooling, and cuttings are transported quickly to the surface. Even though the cuttings are very small, identification of the formation drilled can be made when using air or gas, and indications of gas, oil or water can be detected very rapidly. If the walls of the well tend to slough, or cave into the hole, air or gas circulation is impossible because neither air nor gas imposes much pressure at the bottom of the hole. These two negative aspectes of air or gas circulation are considered more significant than the positive ones. All deep wells encounter water-bearing formation sooner or later.

Although air, gas, or modified drilling fluids such as foam or aerated mud have been used successfully in many places, air drilling is used on less than 1 percent of the total wells drilled today. Spectacular rates of penetration have been obtained with air or gas, but the hazard of a fire or explosion is always present. Compressors and related equipment have been improved and are now readily available in areas where air drilling is feasible.

### Rig Equipment

Skid-mounted compressors furnish the high-pressure air, which can be seen blowing a cloud of dust out of the vent pipe, or blooey line. Air does not circulate in the sense that it is not used over and over again; rather, it makes one trip through the compressors, down the drill stem, and back to the surface and is then blown to waste.

Normally, each compressor is mounted on a skid with an appropriate engine, drive arrangement, air piping, and coolers to reduce the temperature of the compressed air. The compressors should be placed upwind, if possible, from the blooey line.

When preparing the drill with air, the usual arrangement is to rig up first for using mud as the circulation medium. The compressors or a connection to a supply of high-pressure gas is then installed. Next, the blowout preventers and a rotating head are hooked up, and safety precautions are put into effect to minimize the

STUDENT REFERENCE (continued):

fire hazard. Blowout preventers and wellhead connections for drilling with air or gas are used. A rotating head makes a seal around the kelly to prevent the air or gas from leaking during drilling while still allowing the drill stem to be rotated. An exhaust line, or blooey line, is connected below the rotating head to vent the air or gas to a location at a safe distance from the rig.

EVALUATION:

Answer the following questions in writing.

1. Shown a slide of a rotary drilling rig with circulating system components numbered, name the equipment and explain its function.
2. State the five principle purposes of circulation.
3. Why is air and gas not used any more than it is as a circulation agent?

## V. DUTY: Equipment Familiarity

### TASK 8: Identifying Equipment and Assemblies That Make-Up This Auxiliary

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## INTRODUCTION:

In the following lessons you will learn about the major pieces of equipment which are assembled to make a rotary drilling rig. In addition to the major units you will be introduced to a considerable number of smaller items that are required to make a rig function.

## LEARNING ACTIVITIES:

1. You will read student reference section and prepare 3 questions about the material you do not understand.

2. As you read your assignment, list the equipment and assemblies that make-up the auxiliaries of the rotary drilling rig.

3. In your reading assignment you will be referred to figures which illustrate the various equipment and assemblies that make-up the auxiliaries of the rotary drilling rig. Pay particular attention to figures provided in student reference section.

4. You will take part in a class session in which your instructor will provide a detailed explanation of the auxiliaries and answer questions you may have (as you do your reading assignment make a list of questions that you would like your instructor to answer).

## STUDENT REFERENCE:

1. Eddy-Current Brake

   This is an electric-magnetic machine which includes primarily a driven element-being an all-iron rotor, and a stationary member which provides a variable

STUDENT REFERENCE (continued):

and controllable magnetic field in which the driven element revovles. Magnetic forces, induced in the rotor, tend to oppose accelerated rotary movements.

2. Automatic Catheads

Catheads are mounted outboard on both ends of the catshaft of the drawworks. If the drawworks includes a sand reel, it too is mounted on the catshaft which is carried on heavy duty roller bearings located in the frame of the drawworks. Roller bearings also carry the sand reel on the catshaft so that either may rotate independently. The sand reel has its own braking system. The drum is driven by the catshaft through a friction clutch mounted within one of the drum flanges.

The automatic cathead on the driller's side, usually referred to as the "spinning" cathead, normally is used for spinning in and tonging up drill string connections while running pipe into the hole.

The cathead opposite the driller's position, usually referred to as the "breakout" cathead, normally is used to break or loose tool joints while coming out of the hole. After breaking or loosening the tool joints, they are spun out with the rotary. The breakout cathead, in combination with tong block, is sometimes used to tighten connections on large drill collar strings. Use of the tong block doubles the pull and cuts effective jerk line speed in half.

The catline spools, of both catheads, are rigidly connected to the catshaft and rotate with it. The drums are mounted on roller bearings and are provided with built-in friction clutches to govern their operation. Clutch control may be manual, hydraulic or pneumatic. Manual control is most commonly used on spinning catheads so as to provide a "feel" to the operator during a tightening operation. Air controls are most often used on the more remotely located breakout catheads since "feel" in this operation is of little importance.

STUDENT REFERENCE (continued):

3. Power Tongs and Power Slips

Power tongs were developed orginally for well servicing-running and pulling tubing. They were next used on casing jobs and more recently for spinning up and tightening drill pipe and drill collar connections. It has been demonstrated in some instances that their use, going into the hole, saves both time and labor. Furthermore, torque being applied can be readily indicated and easily controlled. There is little or no advantage to their use pulling out of the hole except in unusual situations that do not permit spinning out with the rotary. Power tongs currently in use are generally equipped with hydraulic motors; however, air motors have been used to some extent. They may derive their energy directly from the rig's hydraulic power system or from small engine-drive hydraulic power units.

Crew fatigue may be reduced significantly through use of power slips while tripping. Additional advantages are safety to personnel and protection against damage to drill pipe. Power slips are air-operated from rig air supply. They are available from several manufacturers.

4. Kelly Spinner

Another device, somewhat similar in principle to a small power tong, is the kelly spinner. This device has proved helpul when making connections. Its use eliminates the need for spinning chain when making rat hole connections and improves both speed and safety. These units attach to the lower part of the swivel and may be driven by either air or hydraulic motors.

5. Rig Instrumentation

In the earlier days of rotary drilling, the only instruments to be found on the rig were pressure gauges on the boilers. The second type of measuring device to come into use was the weight indicator.

STUDENT REFERENCE (continued):

In recent years the number and complexity of instruments have multiplied. Currently, a well-equipped rig may have devices to indicate-and, in some cases, to record-a large number of variables.

The Instrument Console - An instrument console mounts vertically in front of the driller's position. The dials are thus grouped to show the driller the performance of each of the major pieces of equipment on the floor. These dials are connected to the respective itmes of equipment by conductors, either tubular or in the form of an electric circuit.

The Weight Indicator - This dial indicates two things: (1) The total weight of the string of drill pipe and drill collars in the hole. This weight is that of the pipe when suspended in the drilling fluid. (2) By use of the second pointer, the dial indicates the weight on the bit. It must be remembered that the faces that work on this dial are changed when the number of lines in the string-up are changed.

Rotary Tachometer - The choice of rotary table speed may depend on many variables, some of which may be difficult to evaluate. Nevertheless, it usually is intended that the table speed be held within specified limits and that the speed in RPM be observed and possibly recorded. Various types of tachometers have been used, but seemingly the most popular includes a simple AC generator, employing permanent magnets which can be driven from any shaft the rotational speed of which is proportional to rotary table speed. The electrical impulses or cycles of the generator are transmitted through conductor cable to a meter or indicating head with a dial graduated to read in RPM. This indicating head contains a ratio adjustment potentiometer, which makes possible calibration of the instrument by adjusting indicated dial reading to agree with an RPM count.

## STUDENT REFERENCE (continued):

Rotary Torque Measurements - It has long been realized that torque at the rotary table varies over a wide range, and that horsepower expended on rotating drill string is something we know too little about. On mechanically driven power rigs, two types of torque indicators have been used. If the rotary table is independently driven by an engine equipped with a torque converter, the amount of slip or differential RPM is indicative of the torque load. When correlated with engine speed this differential RPM is proportional to torque and with readout instrumentation will indicate relative torque values.

Although it is unlikely that large drill pipe in good condition will be literally twisted in two by power ordinarily applied to the table, other hole conditions will be reflected by indicated torque readings at the surface. The torque required by the bit itself is of very small magnitude.

Pump Stroke Indicator - Pump strokes or cycle per minute often are the only available measure of the circulation rate. The most commonly used pump stroke indicator employs an AC generator similar to that used with Rotary Tachometer, previously described. The generator is driven from the pinion shaft of the pump, usually serving as an idler on the V-belt drive to piston rod oiler. Electrical impulses are transmitted to the indicating head and callibrated, in the same manner as described under rotary tachometer discussion. Standard dials are available which show both SPM and GPM. The scales for volume must of course be matched to the stroke length and liner sizes of the pump in use.

Tong Torque Gauge - Catheads can develop a tremendous line pull and must do so when tonging up drill collar connections. Since the amount of torque to be used is a critical matter, tong torque gauges of some sort are almost indispensable. The pull load element may be attached directly to the tong handle or elsewhere in the dead line or snub but more importantly, it must be in line or pull at 90 degrees with tong handle to assure accuracy of indicator readings.

STUDENT REFERENCE (continued):

6. Rate of Penetration Recorders

Conceived originally as geologic tool, a drilling rate recorder of some kind can now be found on almost every rotary drilling rig. Most generally, the present day drilling rate recorder is incorporated in a multi-pen operations recording system which may record any or all of the operating variables for which rig instrumentation has been provided.

Rate of penetration recorders use strip charts which are advanced on a time clock basis independent of the operation in progress. The log recorder in either manner, when correlated with other drilling variables, reflects drillability of the rocks and is useful information for both geologist and driller.

7. Drilling Spools

Choke manifolds and kill lines frequently are connected to casinghead side outlets or to side outlets of the blowout preventers. For high pressure service, many operators prefer that a drilling spool be installed below at least one blowout preventer that can close around pipe. It also is desired by many that a preventer having pipe rams be placed immediately above the casing head so that a well can be shut in at this level to permit changing out rams or to perform other adjustments and repairs to upper units of the stack.

Drilling spools should have side outlets of appropriate size. Also, they should have internal bore and service pressure ratings consistent with the preventers used.

8. Compressed Air

Compressed air is used extensively on modern day rotary rigs for actuating clutches and various rig controls. Air is used also to power BOP accumulator pumps, drive kelly spinners, actuate power tongs and power slips to control catheads. Air compressors, like electrical generating units, require standby equipment. Many mechanical rigs include one or more two-stage compressors mounted atop the compound housing, being V-belt driven from the transmission system. Customarily an independently drive compressor in the utility house automatically takes over when air preesure drops below normal. If compressors are not being driven from the rig engine compound, standby capacity probably will be achieved through use of a second compressor in the utility house.

9. Tools-Miscellaneous

The tools essential to the operation of a rotary rig are numerous.

Down hole tools, not directly related to the primary functions of the drill string proper or to the means of handling it, include such items as reamers, stabilizers, overshots, spears, jars, safety joints, bumper subs, key seat wipers, washover pipe, surveying devices, etc.

Fishing tools most commonly used in recovery operations, when the drill string becomes stuck or comes apart, are overshots, jars, spears, mills and washover assemblies.

Safety tools, intended hopefully to avert fishing jobs or at least to facilitate recovery of tools lost in the hole, are bumper subs, key seat wipers and safety joints.

Rig floor tools are casing tools, cranes, chain hoists, air hoists, wire line mesuring devices, pressure lubricating system, mandrel and accessories for installing drill pipe protectors, kellum's swivel grip for stringing over drilling lines, power grinders, chippers and drills.

Off floor rig tools often to be found are: acetylene cutting torches, arc welders, fork lift trucks spray painting equipment, cementing units, kelly straightener, hydraulic hand pump for pressure testing, guard rails, pipe, racks, truck ramps, stairways, doghouses, etc.

**EVALUATION:**

Answer the following questions in writing.

1. Given a picture of a piece of auxiliary equipment or tool, you will describe its function in the rotary drilling operation.
2. Name 5 various pieces of equipment used on a rotary drilling rig.
3. What are power tongs?
4. What are slips?
5. Tell what fishing tools are used for.
6. Name 4 off-floor rig tools which may be used.

## V. DUTY: Equipment Familiarity

### TASK 9: Develop Safe Working Habits

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## INTRODUCTION:

From this lesson you will learn the safety responsibilities of all persons involved with the drilling operation. Instruction in personal safeguards will be a part of this lesson. Rig-up safety will also be covered. Safely working with or around the drilling rig equipment will also be a part of this lesson.

## LEARNING ACTIVITIES:

1. Read the student reference section provided below and study the responsibilities of each crew member, Personal safeguards, Rig-Up, and Drilling Operations.
2. The class will be divided up into 5 men drilling crews. A series of slides will be shown; these slides may show a specific job being done, it may be some phase of the rig-up, it may be the use of a piece of equipment or hand tool. Each crew will develop a list of safe working practices for each slide. At the end of the slides the class will meet for a general discussion at which time the crews will share their information.
3. From the student reference section prepare 3 questions about material you do not understand or would like to have discussed.

## STUDENT REFERENCE:

Safety is part of everyday living. It is an important consideration in everything we do--in the home, at work or play, on streets and highways--wherever we go. Safe operating practices and procedures are vital in the drilling business because the work is hazardous, involving massive machinery, heavy tools, great physical strength, and when accidents do occur, serious peril to life and limb. Drilling personnel must know how to work safely on a rig in

## STUDENT REFERENCE (continued):

order to protect themselves, costly rig equipment, and the expensive hole being drilled.

Everyone loses from an accident. Injuries result in pain and suffering and may leave a man disabled or handicapped for life. Even minor injuries may cause loss of time from work and lost pay.

More than 90 percent of all accidents are avoidable, being caused by human error rather by mechanical failure. This being the case, it is very important that every man on a drilling rig develop a sense of safety in drilling operations.

The managers of a drilling company--the contractor--have the primary responsibility for safe drilling operations. The oil company, or operator, for whom the well is drilled usually controls the safety of the operation with regard to blowout prevention because the operator nearly always furnishes the casing and directs the mud program.

It is the responsibility of the owners of the drilling equipment to provide safe machinery for the work. The drilling superintendent must ensure that a rig has equipment arranged in such manner that safe operations are possible and that the job is within the operating limits of the rig equipment. Tool pushers must ensure that the rig machinery is operated properly within its design capacity and that a sufficient number of experienced men are available to work. Drillers must operate the rig machinery so that design limits are not exceeded and see that equipment such as drill pipe, wire rope, and tools are not abused. Drillers must see that the crewmen work in a safe manner and that the derrickmen, floormen, and other crew members avoid accidents.

A drilling contractor's safety responsibility includes:

1. providing safe drilling equipment and tools, including mechanical safeguards and safe working conditions;
2. developing safe operating practices and procedures;
3. maintaining a system of rig, equipment, and tool inspection and maintenance;

STUDENT REFERENCE (continued):

A drilling contractor's safety responsibility includes (continued):

4. supervising the drilling superintendent, tool pushers, and drillers in implementing the safety program;
5. providing safety instruction, education, and training for rig personnel;
6. investigating each accident and reporting injuries to the proper authorities; and
7. enlisting the interest and support of all personnel to improve the company's safety record and prevent accidents.

Safety responsibilities of the drilling superintendent include:

1. ensuring that the rig assigned to a specific well can do the job without exceeding the safe operating limits;
2. ensuring that a given rig is rigged up and arranged so that safe operations are possible;
3. informing the tool pushers of the safety features various rig components and of protective care and necessary safety practices;
4. working with equipment engineers and others to improve procedures, designs, and equipment;
5. requiring that tool pushers perform periodic inspections so that hazards may be spotted and corrected;
6. checking that safety standards are met whenever there are changes in equipment or procedures; and
7. checking up on all serious accidents with the tool pusher and with a representative of top management.

Among other duties, the tool pusher is responsible for the following safety measures--

1. seeing that all safety equipment is in proper condition, is properly used, and that prescribed practices are followed;
2. seeing that all practical safety recommendations are carried out to improve working conditions.
3. making sure that the drillers train all crewmen to keep up;

STUDENT REFERENCE (continued):

Among other duties, the tool pusher is responsible for the following safety measures (continued):

4. making sure that the drillers train all crewmen to work safely, particularly as prescribed by the drilling contractor or company;
5. making periodic reports to the superintendent using a rig safety checklist (inspections should be made in the company of a driller, using a different man for each report); and
6. investigating and discussing each accident or injury with the driller and crew to determine its cause and take appropriate corrective measures.

The driller's safety responsibilities include:

1. making sure the new man knows his duties before he goes on the job;
2. seeing that all men are trained in company operating procedures and safety practices;
3. taking necessary steps to correct hazardous conditions and incorrect practices;
4. ensuring that the crew works safely, avoiding makeshift or hazardous ways that might cause personal injury or damage to equipment;
5. seeing that protective devices are in good condition and used when needed;
6. never running the rig faster than the slowest man can keep up; and
7. never assigning a hazardous job to a man who has not had sufficient experience to handle it.

It is vital that all crew members work safely as a team. Regarding accident prevention, each crew member has the following responsibilities--

1. being constantly alert to what is going on, keeping his mind on his job;
2. using safety equipment for his protection (hard hat, proper clothing, gloves, shoes, goggles, safety belts, and appropriate tools for each operation);
3. avoiding the use of makeshift tools, misfit or defective wrenches and reporting these as soon as noted;

## STUDENT REFERENCE (continued):

Crew member safety responsibilities (continued):

4. practicing safety consciousness--each crew member member should conduct his work to avoid injury and learn to foresee and prevent as many accidents as possible;
5. using ladders and stairs as intended, not jumping off the derrick floor, pipe racks, or trucks and not sliding down a stand of drill pipe or riding the catline;
6. avoiding walking under drill pipe or casing being brought into the derrick or laid down the racks;
7. practicing good housekeeping, keeping everything orderly, seeing that tools are placed in a tool rack, and the floor cleaned up and free of mud;
8. remembering that practical jokes are out of place on a drilling rig and can be the cause of serious injuries.

Oil- and gas-well drilling is a serious and exacting business. Drilling operations should be conducted by careful, conscientious, and responsible personnel. Careful planning, alertness, and effort on the part of each crew member must be coordinated in a total effort to avoid accidents and to increase work potential.

### Clothing

Safety hats should be worn at all times by all members of the drilling crew and by visitors to the rig floor. Nonconductive hard hats are preferred; this type of hat protects the worker from impact and penetration of falling or flying objects and, to a lmited degree, from electric shocks and burns. Safety helmets should be of nonmetallic construction.

The use of gloves whenever practical is recommended. Gloves prevent minor injuires to employees handling rough materials or skin irritants. Only short, tight-fitting glvoes should be worn. Rig personnel should never wear finger rings while on the job.

Rig personnel should wear only close-fitting clothing. Long-sleeved shirts, with tails tucked in, should be worn at all times.

## Goggles

Appropriate eye protection should be provided and maintained in good condition on each drilling rig. Employees should wear approved safety glasses or goggles when chipping, scraping, buffing, or breaking any metal or other material that may produce flying chips.

## Working Posture

Rig personnel should always maintain good work posture, with firm footing and good balance.

The general practice is for the oil company, or owner of the well, to provide a clear, level location with pits and access road arranged to accomodate the specific rig to be used. The drilling contractor's superintendent and/or the rig tool pusher arranges for trucks and other equipment to move the rig, to spot the equipment on location according to the rig plan. After the derrick is assembled, blocks strung, and power to the drawworks ready, the derrick or mast is raised. At this time the crews begin working shifts (tours) on a 24-hour basis. Rigging up usually continues until the well is ready to spud.

Rigging up is hazardous because the work is nonroutine, heavy machinery and equipment are invovled, and many jobs are being done at the same time in close quarters. Avoidable accidents often happen during rig up because many people are trying to complete their jobs simultaneously. Because it is the beginning of a job, some of the men may be new and inexperienced; they may not be familiar with the equipment or its arrangement.

The operation of a drilling rig is accomplished with a drilling crew of four to six men. The rig crew and their immediate supervisor, the tool pusher, handle normal drilling operations, minor repairs, sometimes run casing, and take care of blowout prevention and completion work.

The basic drilling a crew consists of a driller, a derrickman, two floormen, and sometimes a motorman. On most rigs, the basic crew is responsible for drilling operations and maintenance of all components of the rig.

STUDENT REFERENCE (continued):

## Derrick (Mast)

Provisions should be made to prevent derricks and portable cantilever, telescoping, and jackknife masts from overturning because of high winds. The guying system should be constructed in accordance with generally recognized safe practices in the industry, and manufacturer's guying specifications should be followed.

An auxiliary means of escape should be provided from the principal inside derrick platform of a standard derrick or from the pipe-racking platform of a mast. This auxiliary means of escape should be a specially rigged line that an employee can use if a blowout or other emergency should cut off his escape by way of the derrick or mast ladder.

Platforms should be provided inside the derrick in each elevation where an employee is normally required to handle pipe or other equipment that is racked in the derrick.

Derrick safety belts and lifelines should be maintained in good condition. They should be carefully inspected at regular intervals, and damaged belts or lines replaced immediatley. Derrick safety belts should be adjusted to the wearer to fit as snugly and comfortably as possible.

## Drawworks, Rotary, Hose, Swivel, Kelly

The throttle for the prime mover of a drawworks or rotary should be designed, installed, and maintained in such a manner as to provide the driller at his normal operating station safe and convenient control of the prime mover.

Drawworks and rotary shafts should not have exposed keyways or keys that could catch clothing; if necessary, guards should be provided. Drawworks, rotary gears, and chain drives should be enclosed by well-constructed metal guards; it is important that these guards be in place any time the machinery is in motion.

A substantially constructed metal step, or working surface, should be provided around the top outer surface of a rotary upon which it is normally necessary for employees to stand when working around the rotary.

STUDENT REFERENCE (continued):

The standpipe end of a drilling or rotary hose should be securely fastened to the derrick by a cable of not less than 5/8-inch diameter or by a chain not less than 1/2-inch thick and clamp arrangement on the hose. The swivel end of the hose should be secured by a similar clamp and wire-rope or chain arrangement attached to the body of the swivel.

### Crown Block, Traveling Block, Hook, Wire Lines

Crown-block assemblies on standard derricks should be securely bolted in a place; the bearing caps should be firmly bolted to prevent the sheaves from jumping out of the housings and falling. The sheaves of every traveling block should be guarded with suitable heavy metal nip-point guards, so desinged that they enclose the sheaves. Traveling-block-sheave guards should be securely fastened to the block and arranged to prevent an employee's hand being drawn into the nip-point, where the hoisting line begins contact with the sheaves.

Hoisting lines should be anchored on the dead end by means of a cylinder or drum around which two or more turns can be made before the end of the line is clamped by an arrangement equal in strength to the breaking strength of the line.

### Drill-Pipe Slips, Tongs, Spinning Chain, Elevators

Drill-pipe slips must be maintained in good condition and used on the size pipe that they fit. Worn slips may permit the pipe to drop, with subsequent damage to the pipe and hazard to the employes. Misfitting slips may gouge, scar, or otherwise damage the pipe.

To facilitate handling and to ensure latching when tongs are placed on pipe or tool joints, tongs should always be clean, lubricated, and fitted with the correct jaws. When not in use, tongs should be hooked back, away from the middle of the derrick floor.

Spinning chains should be of the proper length, without surplus, and maintained in good condition. The tail end should be provided with a short (16-inch) length of manila or nylon rope to provide a handhold on the end of the chain in order to reduce the chance of hand or finger injuries.

Cathead, Catline, Air Hoist, Rigging Practices

A cathead on which a catline is manually wound should have a reasonably smooth surface without deep grooves. It should be equipped with a divider for separating the first wrap of the catline from subsequent wraps, and it should be free of projections on which an employee's clothing could be caught during operation.

Electrical Hazards

Rig wiring should be installed in a manner that protects it from abrasion, from being trampled, or from being burned by hot pipes. To avoid short circuits, it should be insulated to resist weather and handling. Makeshift wiring should not be permitted. Lead-in cables from the generators to the derrick should be located where they cannot be damaged when the drilling rig is operating or when heavy tools are being moved.

Fixed lamps on derricks and masts should be equipped with reflectors or shields and located to minimize glare or hindrance to vision. Lights in the derrick should be directed toward the objects to be illuminated but away from the eyes of the driller and derrickman.

The following are rules for employees whose duties include the operation of electrical equipment.

1. Low voltage equipment such as 100-volt lighting circuits can be, under certain conditions, very dangerous. In operating electrical equipment, workmen should follow instructions and not take chances. If equipment does not operate properly, their immediate supervisor should be notified immediately.
2. A disconnecting switch should never be opened while the motor is running. A push-button starter or some other approved type of switch should be used.
3. When it is necessary that an operation take place or that a structure be built close to any electric line, an electrician should be notified.
4. Water, particularly salt water, is a good conductor of electricity. Therefore great care should be taken when a steam or water hose is used to wash equipment near electric motors. Only fire extinguishers approved for electrical fires, class C, should be used on or near electrical equipment.

STUDENT REFERENCE (continued):

Duties on electrical equipment (continued):

5. Transformer banks should be kept fenced and Danger signs placed in the vicinity. Any wire fences around them should be grounded.
6. An electric wire that may be on or near the ground should never be touched. Dangerously high voltages may exist in seemingly harmless wires.
7. Broken wires, poles, guys, and similar hazards should always be reported and repaired immediately.
8. Switches opened to permit work on lines or equipment should be tagged with warning signs to alert employees that the switches must not be closed. A lockout device is preferred.
9. All rubber goods should be tested before being used on electrical equipment.
10. Derrick wiring should not be strung on girts. It should be properly installed with approved type fasteners.
11. Ground wires are for the protection of the employees and should not be disturbed. They should be properly maintained.
12. Rubber mats should be provided for employees to stand on while operating switch panels. Wooden mats allow circulation between the rubber mats and the floor.
13. When moving high loads with a truck or tractor near overhead power lines, a lineman should direct the move.
14. Employees should not use a power-line pole as a snub for a winch line when material is being moved or if a truck is stuck. There is danger of shorting the wires when the strain is taken off the pole. The contact of two wires may cause a short that results in the burning and parting of wires, thereby allowing the parted wires to fall to the ground
15. If junction boxes leak, they should be repaired. Holes for drainage should not be drilled in junction boxes.
16. When working under or near high voltage lines, employees should take care that gin poles, guys, lights, and other objects are not allowed to contact them.
17. All electric motors, electric equipment, lights, and switch boxes should be grounded.

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STUDENT REFERENCE (continued):

Duties on electrical equipment (continued):

18. All portable electric tools should be grounded.
19. The use of pennies and other solid metal behind fuse plugs may result in fire and should be avoided. Install proper fuses. It is recommended that all fuse boxes be replaced with approved circuit-breaker boxes when the change is convenient.
20. Power should be turned off prior to the removal of fuses to prevent possible shock.
21. Brass key sockets or uninsulated pullchain sockets should not be used.
22. Broken and burned-out bulbs should be replaced as soon as possible. The circuit should be turned off before removing or replacing bulbs.
23. Exploisonproof or vaporproof lighting should be used. Cover globes and gaskets should be kept clean in order to allow maximum light transmission.
24. Where derrick floodlights and hangers are used, they should be equipped with safety straps fastened to the girts.
25. A set of approved electrical-service tools should be available for minor repairs.
26. The backs of all control panels should be properly guarded and fastened.

Running Casing, Landing, and Testing

Heavy strings of casing require special elevators and slips, and usually longer and heavier links are obtained. If a powered stabbing board is not available, sutiable boards should be put up to enable the derrickman to stab the shorter casing makeup is safer than using a spinning rope and cathead. Casing tongs lessen crew fatigue, are less hazardous, and ensure that the proper torque is obtained on each joint. Care should be exercised when running casing not to damage the pipe or threads as it is moved from the rack to the derrick floor, picked up, stabbed, and made up into the string.

EVALUATION:

Answer the following questions in writing.

1. Drilling rig safety is the concern of ____________ ________________________________________.

EVALUATION (continued):

2. People make safety. List the people (or their job titles) who are mainly concerned with rig safety.

3. Name four items of safety equipment that are worn or used as personal safeguards by drilling rig personnel.

4. Avoidable accidents happen during rigging-up operations because:

   ______________________________________________

   ______________________________________________

   ______________________________________________

5. The supervisor in charge of raising the derrick or mast must ensure that:

   ______________________________________________

   ______________________________________________

6. Wirelines should not be struck with any object such as a steel hammer, hatchet, or crowbar, which could cause ______________ and ________________.

7. Three safety rules when using a catline on a cathead are as follows:

   (1) Never ______________________ than necessary on the cathead.

   (2) Never work on the cathead if no one is at ____________________ ____________________.

   (3) Never stand inside coils of ______________ on the floor.

8. Time is of the essence in killing a threatened well kick. Early recognition of the warning signs is important. List three or more signs that a well kick is about to happen.

## VI. DUTY: Well Completion

### TASK 1: Cementing

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INTRODUCTION:

In this lesson, the cementing process will be studied. You will become familiar with the methods and reasons for cementing.

LEARNING ACTIVITIES:

1. Slides of cementing equipment and processes will be presented and discussed in class. If possible, a representative from one of the cementing companies will be present to answer questions.

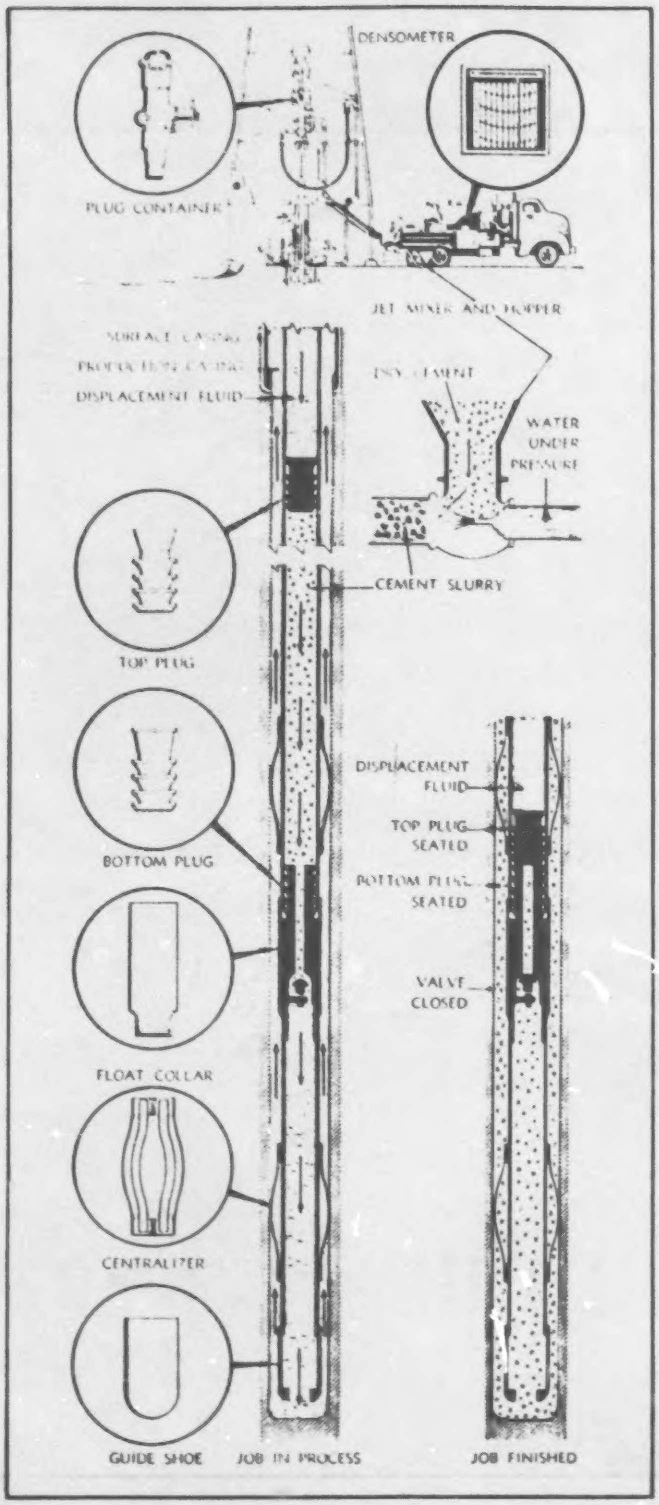
2. Read and prepare 3 questions about the student reference material.

STUDENT REFERENCE:

When the casing is run, the next job is to cement the casing in place. A cementing company is usually called for this job but the roughnecks on rig crew is there to help when needed.

Cementing companies have different types of cement and have special vehicles to transport this material to the well site. Large amounts of cement are moved along with the equipment needed to mix the large amount needed to the drilling location. The dry cement is mixed with water using a machine called a jet-mixing hopper. The dry cement is gradually added to the hopper and thoroughly mixed by a jet of water to make a very watery, thin cement, or slurry.

Pumps pick up the cement slurry and send it to a valve called a cementing head which is mounted on the topmost joint of casing that is hanging in the mast above the rig floor. Just before the slurry arrives, a rubber plug or bottom plug is released from the cementing head and goes down the casing in front of the cement slurry. The bottom plug stops or seats on the bottom of the well and continued pressure from the cement pumps open a valve through it. The cement slurry continues through the bottom plug and starts up the space between the outside of the casing and the walls of the well, known as the annular space is filled with the cement slurry.


DENSOMETER
PLUG CONTAINER
JET MIXER AND HOPPER
SURFACE CASING
PRODUCTION CASING
DISPLACEMENT FLUID
DRY CEMENT
WATER UNDER PRESSURE
CEMENT SLURRY
TOP PLUG
BOTTOM PLUG
FLOAT COLLAR
CENTRALIZER
GUIDE SHOE
JOB IN PROCESS
DISPLACEMENT FLUID
TOP PLUG SEATED
BOTTOM PLUG SEATED
VALVE CLOSED
JOB FINISHED

CEMENTING PROCESS

## STUDENT REFERENCE (continued):

The top plug is sent down the casing after the last of the cement slurry and is pushed down with water. This pushes the cement slurry down the casing and fills the annular space. When the top plug reaches the bottom plug, the pumps are shut down. The casing is now full of water. Now the cement will need to harden before anything else can be done. This waiting time is referred to as waiting on cement, or WOC.

When the cement hardens, tests will be run to be sure of a good cement job. The cement should completely surround the casing to properly support the casing. The cement will keep the well walls from sloughing off or caving in. It will protect the casing from corrosion by keeping corroding agents away from it.

The hardened cement will seal off troublesome formations and prevent fluids from one formation from flowing up or down the hole and polluting the fluids of another formation such as fresh water.

## EVALUATION:

Answer the following questions in writing:

1. Name three reasons for cementing a well?
2. What is a bottom plug? Explain its use.
3. What is a top plug? Explain how it is used.
4. Where is the cement when the cement job is complete?
5. Who does the cement job?
6. What is in the casing when the top plug is pushed to the bottom?

## VI. DUTY: Well Completion

### TASK 2: Logging

INTRODUCTION:

This lesson will deal with the technique known as well logging or just logging.

LEARNING ACTIVITIES:

1. Slides of the logging process and equipment will be viewed and discussed in class. If possible, a representative from one of the West Virginia logging companies will be present to assist in the discussion and answer questions. Some well logs will be available for viewing.
2. Read and prepare 3 questions about the student reference material.

STUDENT REFERENCE:

The full length of drill string is tripped out and a logging company is called to the well sight. This company will have a truck-mounted portable laboratory and special tools called logging tools.

The special logging tools are lowered to the bottom of the well on a wireline and slowly reeled back up. As the tools come back up the hole, the measure of the properties of the formations they pass are recorded in the truck-mounted laboratory. These records, called well logs, then can be studied by a geologist or engineer to determine if the well has oil or gas, where it is in the well, and how much.

Logging companies use different methods of logging a well. Some companies use electric logs and measure natural and induced electricity in the formations. Sound is sent into the formations by some companies and then the sound reactions are measured. Still another method is radioactivity logs which measure the effects of natural and induced radiation in the formations.

EVALUATION:

Answer the following questions in writing:

1. Name three different types of logging methods used in West Virginia.
2. What are well logs used for?
3. Who will do the logging?
4. What tools are used to log a well?
5. What do logging companies do?
6. What do logs tell about formations?

## VI. DUTY: Well Completion

### TASK 3: Perforating

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INTRODUCTION:

This lesson will cover the process known as perforating.

LEARNING ACTIVITIES:

1. Slides of perforating equipment, tools and the perforating process will be shown and discussed in class. If possible, a representative from a perforating company will be present to participate in the discussion and answer questions. Perforating guns, tools, and trucks may be on hand for the student to see.
2. Read and prepare 2 questions about the student reference section.

STUDENT REFERENCE:

The producing formation or pay zone is sealed off by the casing and the cement and new holes need to be made so the gas or oil can flow into the well. Making these holes through the casing and cement into the pay zone is called perforating and a special perforating company is called for this job.

### Perforating

Perforating is the process of piercing the casing wall and the cement to provide holes through which formation fluids may enter. Perforating may also be used to provide holes in the casing so that materials may be introduced into the annulus between the casing and the wall of the borehole. Regardless of its purpose, perforation should:

1. provide a clean, undamaged access between the annulus and producing formation;
2. penetrate the producing interval as far as possible;
3. shoot a smooth and round entrance hole in the casing;
4. produce minimal casing and cement damage; and
5. produce the maximum flow rate with the minimum number of perforations.

## Perforating Methods

There are two basic methods of piercing the casing wall: bullet perforating and jet perforating. It is generally agreed that there is no one best method. A bullet perforator offers greater performance in formations of low to moderate compressive strength, and jet perforating is generally better in rocks having high compressive strength. When determining which method to use, many factors - such as casing size, formation fluids, the formation, cementing procedure, hydrostatic pressure, and well temperature - must all be considered.

After the best method of perforation has been determined, a hoisting truck lowers a perforating gun that carries the assembly of charges into the hole on a wireline. Sometimes a mechanical collar locator, which has been installed at the top of the gun, is used by the perforating crew to help determine the exact position of the gun in relation to the formation outside the casing. Knowing the location of the collars makes it possible for the gun to be placed in the well at the desired point. A sonic device and a magnetic locator, which is activated by the extra thickness of metal at each casing coupling, are also used to determine the location of the gun, as is the odometer that measures the amount of line fed into the hole to lower the equipment.

Bullet Perforators. Bullet perforating was developed in 1932 and has been widely used since then. The bullet perforator is a multi-barrel gun that is lowered into the hole on a wireline, and it is fired electrically from surface controls. Bullet guns leave no debris in the well to plug chokes and cause other production problems. Bullets cause little casing damage and less damage to the cement sheath between the pipe and the wall of the hole than jet charges.

Jet Perforators. Jet perforating, which was developed in 1946, is similar to bullet perforating except that shaped-charge explosives are employed instead of bullets. Hollow carrier guns can be used in small pipes, and capsule charges can be used for 1.9-inch pipe. Shaped charges can be obtained as link, bars, or strip assemblies for extremely small pipe. After-shot debris is minimum with hollow carrier shaped-charge devices, but capsule charges usually leave appreciable amounts of metal pieces in the hole. Ribbon or wire-type jet guns leave less debris than capsule-type jets. Hollow carrier jet perforating devices will absorb the explosive energy of the charges, thereby minimizing casing and cement damage. Jet guns with exposed charges, such as strip or capsule-type jets, can cause deformation or possibly rupture the casing.

STUDENT REFERENCE (continued):

## Thru-Tubing Perforation

A much safer well completion technique is to make the perforations after the tubing has been run and the packer set. Thru-tubing perforation has been made possible by the development of powerful perforating devices small enough to run through tubing. By running the tubing, displacing the fluid with water or other light liquid, setting the packer, and then perforating, the well is under absolute control at all times.

## EVALUATION:

Answer the following questions in writing:

1. What are perforations?
2. What company will perform the perforating job?
3. How does the perforating company know where to make the perforations?
4. What are the perforations made with?
5. Why are perforations needed?

## VI. DUTY: Well Completion

### TASK 4: Fracturing and Acidizing

## INTRODUCTION:

This lesson will cover two procedures used to enhance production.

## LEARNING ACTIVITIES:

1. Slides of the fracturing acidizing process will be presented. Slides of the equipment used in these two processes will be shown and a representative from a West Virginia fracturing company will be present to participate in a discussion and to answer questions.
2. Read and prepare 2 questions about the student reference material.

## STUDENT REFERENCE:

Formation stimulation treatments were originally developed to rejuvenate old or poorly producing wells. Today, stimulation treatments are more frequently used to initiate acceptable producing rates in both new wells and new zones in old wells. The term well stimulation actually encompasses several processes used to enlarge old channels or to create new ones in the producing formation. Since oil usually occurs in the pores or cracks of sand or limestone formations - and seldom, if ever, in an underground pool like a tank - enlarging or creating new channels means that the oil or gas will move more readily to a well. Many reservoir rocks are so dense that they do not have pore space or fractures adequate for production. Such reservoirs are said to be "tight"; the small smount of oil or gas can only reach the well through natural channels or through artificial fissures.

Three methods have been developed to enlarge or open new channels to a well. The first one was nitro shooting, a method involving explosives; it was introduced over one hundred years ago in Pennsylvania. During the 1930's, acid stimulation, the second method, became commercially available. Hydraulic fracturing was introduced in 1948, making it the third stimulation method.

## Explosives

The importance of shooting wells with high explosives to improve their productive capacities was realized as early as the 1860's. Toward the close of the century, it became fairly routine practice, and the technique of using nitroglycerin was continued until acidizing and hydraulic-fracturing techniques were introduced. Well shooting began to decline in 1940 and had almost disappeared in American oil fields by 1960.

There has, however, been a revival of interest in explosive fracturing in recent years because certain kinds of tight formations do not respond readily to either acidizing or hydraulic fracturing. Also, experience has shown that many of the older wells that were shot are still producing commercially, while wells that were hydraulically fractured or acidized are not.

## Modern Explosive Techniques

Now explosives are used in two basic ways to stimulate a formation. The first is to concentrate detonation only in the borehole. The second is to inject the explosive away from the wellbore for dispersed detonation within a fracture system. The latter method is new and has been made possible only by the development of special explosive materials and handling techniques. It is claimed that explosive fracturing will enlarge the effective wellbore; will eliminate nearby formation plugging; and, at the instant of the explosion, will furnish a source of high-pressure gas to force fluid into the formation at injection rates equivalent to 20 tons of water per second. The formation of rubble that is said to be produced by explosives should prevent fracture healing, rendering the use of proppants unnecessary.

One of the more modern explosive techniques calls for following the initial detonation with progressively larger intensity explosive treatments. After each detonation, formation materials is circulated out, and well performance is recorded. No solid stemming, or tamping, materials is used, and it is claimed that horizontal fractures tend to form better by not injecting material into the fractures.

In another method, a single large-capacity charge is placed in the borehole and set off by a time-clock detonator and booster, while the rest of the borehole and casing is protected by solid stemming of gravel and cement. With this method, fracture patterns are not oriented because they do not depend on existing weakness planes in the formation. It is claimed that concentrating the bagged slurry explosives generates the highest volume of gases for fracture extension. Costs are said to compare favorably with hydraulic fracturing.

## STUDENT REFERENCE (continued):

### Modern Explosive Techniques (continued):

A third method uses neither solid nor slurry explosive, but a liquid manufactured at the well site from components transported in standard trucks. The explosive liquid can be used to break down the formation, or it can be injected into previous fractures or porous zones. Proppants, thickeners, and fluid loss agents can be added to the liquid, and, when it is detonated far out from the wellbore, the fracture system can be appreciably enlarged. Safe operation is insured by placing the explosive away from the wellbore, thus eliminating the need for solid stemming.

### Nuclear Explosives

The lower the permeability of the rocks in a formation, the smaller the chance of achieving economic production. Many such rocks are known to contain vast accumulations of hydrocarbon deposits. It is therefore logical that some extraordinary means could be developed to raise productivity to a satisfactory level. One such possibility is an explosive-stimulation treatment using a nuclear device.

Two nuclear tests conducted in the late 1960's indicate that a large increase in productivity can be achieved by using nuclear explosives in tight gas-bearing formations. The cost of these tests, however, was extremely high. Also, a number of special problems are associated with nuclear stimulation, not the least of which is public concern with radiation. Continuing research is addressing these problems.

### Acid Stimulation

Well servicing rigs are frequently called in to prepare both new and old wells for acid treatment. The primary purpose of this type of well stimulation treatment is to dissolve rock, thus enlarging existing channels and to open new ones to the wellbore. Oil field acids must create reaction products that are soluble; otherwise, solid materials would be precipitated and plug the pore space in the rocks. The acid must be relatively safe to handle, and, since large volumes are used, it must be fairly inexpensive. Reservoir rocks most commonly acidized are limestone - calcium carbonate - and dolomite, which is a mixture of calcium and magnesium carbonates.

### Additives

Additives are used with oil field acids for many reasons, but the most important is to prevent or delay corrosion - that is, to inhibit the acid from attaching the steel tubing or casing in the well. Some inhibitors will

## Additives (continued):

prevent an acid from working on steel for ten to twelve hours, even under fairly high bottomhole temperatures. Surfactants are another type of additive. They are mixed in small amounts with an acid to make it easier to pump the mixture into the rock formation and to prevent acid and oil from forming emulsions.

Sequestering agents are added to control the reprecipitation of iron deposits from spent acid solutions from scales of iron sulfide, iron oxide, and iron carbonates found in oilwell tubing and casing. Suspending agents, which are yet another type of additive, are used to hold the fine clay and silt particles that sometimes remain in suspension after an acidizing treatment.

## Placement Techniques

Most limestone and dolomite formations have low permeabilities. Acid injection into these low-permeability formations, even at moderate rates, usually results in a fracture type of acid treatment - the most widely used treatment for well stimulation with acid. Another type of treatment - interstitial, or matrix, acidizing - also results in production increases. Interstitial acidizing consists of treating at a rate and pressure low enough to avoid fracturing the formation. This technique should be considered whenever formation damage is present or whenever a water zone or gas cap is close and fracturing might result in high water or excessive gas production.

A properly planned formation acidizing treatment will make new flow channels; extend and enlarge natural flow channels; and remove water blocks, emulsion blocks, and deposited solids from the flow channels contacted. The resulting increased permeability will result in an incresed flow of production into the wellbore under the existing formation pressure.

Preflushing is a technique that is often used ahead of an acid treating solution to prepare or condition the formation so it will accept the acid in the most favorable sections. An oil preflush will permit the acid to react with the oil-producing interval of a formation but will restruct the invasion of acid into the water-producing strata. Spotting of an acid treatment is commonly employed to place a quantity of acid solution in the annulus of a well. The purpose of this technique is to remove permeability damage caused by mud filter cake or scale deposit on the face of the producing formation, to free stuck drill pipe, and to dissolve junk in the hole.

STUDENT REFERENCE (continued):

Placement Techniques (continued):

Displacement of the acid solution with more than the volume of fluid required to clear the tubing or casing is sometimes necessary. The exact amount of overflush when using a retarded acid will be related to the reaction time of the acid. If reaction time is longer than injection time, greater penetration can be obtained by overdispolacing the acid. Just enough overflush should be used to keep the acid moving within the formation until it spends.

The injection rate of an acid treatment can greatly influence the placement of live acid and therefore the success of the treatment. Low injection rates are recommended for repairing shallow formation damage or when fracturing the formation is not required. High injection rates are required for deep penetration of live acid. High rates usually involve high pressures, and the formation is likely to be fractured during such treatments.

## Hydraulic Fracturing

In recent years, formation fracturing by hydraulic pressure has gained wide acceptance in the oil trade. Since hydraulic fracturing does for sandstone reservoirs what acid treatment does for limestone or dolomite reservoirs, this type of stimulation may result in commercial production in an area where it was not feasible before.

Essentially, the hydraulic fracturing process consists of applying hydraulic pressure against the formation by pumping fluid into the well. This pressure actually splits the rocks. Hydraulic fracturing is used to accomplish four basic jobs: (1) to improve the productivity of a well by creating penetrating reservoir fractures, (2) to improve the ultimate recovery from a well by extending the flow channels farther into the formations, (3) to aid in secondary recovery operations, and (4) to increase the rate of injection of brine and industrial waste matrial into disposal wells.

Most wells are fractured on initial completion, and refracturing to restore productivity of a well is a regular procedure. Extension of the existing fractures will usually improve well productivity. Fracturing fluid volume is often two to four times larger than the original volume, and pumping rates may be similarly increased.

## Propping Agents

During early experiemental work, it was discovered that a hydraulically formed fracture tends to heal, or lose its fluid-carrying capacity, after the parting pressure is

## Propping Agents (continued):

released unless the fracture is propped open in some manner. This is the function of proppants, or propping agents - to hold the fractures open. Sand, nutshells, and beads of aluminim, glass, and plastic may be used as propping agents. Various tests are possible to determine the most suitable material for an individual case. Obviously, the material should not be too soft, or it will flatten under pressure and reduce or close the flow channels in the fracture. Very hard materials, on the other hand, tend to embed themselves in softer rocks.

Spacer materials are used between the particles of the proppant to insure optimum distribution of the proppant. The spacer materials should have the same specific gravity as the proppant, be insoluble in the fracturing fluid, and be removable by injected solvents or by oil or water produced by the formation. Common spacer materials are urea, hydrocarbon resin, and sodium bisulfate.

## Fracturing Fluid

The fracturing fluid must not only break down the formation, but it must also extend and transport the propping agent into the fracture. A penetrating (high fluid loss) fluid will break down the formation more easily, but extension of the fracture and placement of the proppant are easier to obtain when using a nonpenetrating (low fluid loss) fluid. Fluid-loss characteristics vary not only with type of fluid used, but also with the formation to be fractured. Whenever possible, the fluid should be tested on the formation rock in questions.

The fracturing fluid, along with the additives used to modify its properties, the proppant, and spacer, is often a very complex substance, and its selection requires the utmost care. Knowledge of the properties of the various possible fluids and how to modify them if necessary to achieve the desired effect is vital if the proper fluid for a particular well is to be selected. A good fracturing fluid should have a low lead-off rate (i.e., low fluid loss), the ability to carry the propping agent, and low pumping friction loss.

Oil-base, water-base, and acid-base fluids are used for fracturing. Choice of the most suitable base depends on the chemical nature of the rock, its physical characteristics, and the nature of the reservoir fluid. Acid-base fluids are generally used in the fracturing of limestone or dolomite formations.

## Planning the Job

Although most formations can be fractured, the best effect is achieved in hard to medium-hard rock rather than in soft or unconsolidated formations. The reason for this lies in the relative ability of the propping agent to keep the fracture open and maintain flow capacity. If a well is to produce additional oil as a result of fracturing, it must, of course, be determined beforehand whether much oil is present and whether enough reservoir pressure exists to move oil to the fracture. Drill stem tests, cores, and so forth will usually provide such information.

Fracture treatments are designed on the basis of various conditions of pipe size, injection rate, wellhead pressure, and required hydraulic horsepower. Besides choosing the correct fracture fluid, proppant, spacer, and additives, it is also necessary to decide on the total fluid quantity and the injection rate. Hydraulic power can be calculated or determined by using charts that show the amount of power needed for various rates of pumping and different pressures.

## Preparing the Well

A formation should be cleaned before the fracturing treatment because perforations may be plugged with scale, paraffin, or other materials that should not be pumped into the formation. Plugged perforations can also cause high-pressure treatment or even the failure of the fracturing objective by diverting the fracture into another zone.

In addition to cleanout, it is customary and advisable to conduct a formation pressure buildup test before undertaking a fracturing treatment. This test will usually determine the cause of low productivity. Possible causes are (1) permeability reduction near the well, (2) low permeability throughout the reservoir, or (3) reservoir pressure depletion. Fracture treatments can remedy the first two causes listed but may be ineffective if the cause is reservoir pressure depletion. Other tests - such as core analyses, offset well data, and drill stem tests - can also be used to help identify the causes for low productivity. After the diagnosis, the optimum fracturing treatment can be designed for the well.

## Fracturing Techniques

Long, thick, or multiple-interval producing zones can be treated by means of a double-packer arrangement, stage treatments using ball sealers, or limited entry techniques.

## STUDENT REFERENCE (continued):

### Fracturing Techniques (continued):

An early means of fracturing utilizes double packers, which may be a straddle-packer arrangement or a retrievable bridge plug and packer.

A more commonly employed method of stage treating through perforations is to use sealing balls. These balls are injected into the moving stream of fracturing fluid, using a special ball injector. Generally, one ball is injected for each perforation. Seated against the perforations, they will direct treating fluid selectively through each perforation. When injection is stopped, the sealing balls will no longer be held against the perforations and will fall to the bottom of the well.

In the limited entry technique, a predetermined limited number of perforations are used to control fluid entry. Each perforation acts as a choke, thus bottomhole casing pressure increases as the injection rate is increased. This increase of pressure will be enough to initiate a fracture in the next zone. The process can be continued until all zones are being fractured or until the maximum permissible pressure on the casing is reached.

## EVALUATION:

Answer the following questions in writing:

1. Name two processes used to increase well production.
2. How does the acidizing method help increase production?
3. How does the fracturing method help increase production?
4. What do proppants do?
5. Give three examples of proppants.
6. Who will perform the well enhancement process?

VI. DUTY: Well Completion

## TASK 5: Install the Christmas Tree and Tubing

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## INTRODUCTION:

In this lesson, the need of different types of well heads and reasons for and the process of running tubing will be examined.

## LEARNING ACTIVITIES:

1. Slides of different well heads will be presented with sampler of well heads and tubing being available for examination. The different type of well heads, control valves, chokes, and the tubing process will be discussed in class.
2. Read and prepare 2 questions about the student reference material.

## STUDENT REFERENCE:

The oil and gas can flow into the casing after it is perforated but normally a well is not produced through the casing. To produce a well, a smaller pipe, called tubing, is put inside the casing and the oil and gas flows to the surface in this tubing. When the tubing is started down the well, a packer is put on the outside of the leading end and is placed at a depth just above the producing zone.

When the packer is expanded, it grips the wall of the production casing and forms a seal in the annular space between the outside of the tubing and the inside of the casing. Thus, as the produced fluids flow out of the formation through the perforations, they are forced to enter the tubing to get to the surface.

When casing is set, cemented, and perforated and when the tubing string is run, then a collection of valves called a Christmas tree is installed on the surface at the top of the casing.

STUDENT REFERENCE (continued):

The wellhead is the equipment used to maintain surface control of the well. It forms a seal to prevent well fluids from blowing or leaking at the surface. The conditions expected to be encountered in the individual well determine the type of wellhead that is needed. Sometimes, all that is required is a simple assembly to support the weight of the tubing in the well. In other cases, the control of formation pressures is necessary, and a high-pressure wellhead is required.

The wellhead is made up of a combination of parts called the cassinghead, tubing head, Christmas tree, and pressure gauges.

The casinghead is a heavy steel fitting at the surface to which the casing is attached. It provides a housing for the equipment from which intermediate strings of casing are suspended. During drilling and workover operations, the casinghead is used as an anchor for the pressure control equipment that may be necessary.

Similar in design and use to the casinghead, the tubing head supports the tubing string, seals off pressures between the casing and the inside of tubing, and provides connections at the surface with which the flowing liquid or gas can be controlled. The tubing head is supported by the casinghead if a casinghead is used on the well.

The control valves, pressure gauges, and chokes assembled at the top of a well to control the flow of oil and gas after the well has been drilled and completed are known as the Christmas tree, so named because of its shape and the large number of fittings branching out above the wellhead. The pressure gauges reveal casing and tubing pressures. By knowing these pressures under various operating conditions, better well control is possible.

EVALUATION:

Answer the following questions in writing:

1. What is tubing?
2. Why is tubing put in the well?
3. What is the packer used for?
4. How is the tubing held in the well?
5. What is a well head needed for?

## VI. DUTY: Well Completion

### TASK 6: Set Up the Separator and Tanks

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**INTRODUCTION:**

In this lesson the reasons for a separator and how it works will be explored.

**LEARNING ACTIVITIES:**

1. You will attend a classroom lecture and discussion on separators. Diagrams, and slides of separators will be viewed. Exploded views of separators will be studied.
2. Read and prepare 2 questions about the student reference material.

**STUDENT REFERENCE:**

Well fluids are often a complex mixture of oil, gas, and water, and they must be separated into their components and treated. This is a difficult job, and vapor recovery, evaporation control, and fire hazard elimination are some of the major considerations during this phase of production.

The simplest type of equipment used to separate the liquids from the gases is a tank in which the force of gravity is used to achieve the separation. Oil, which is heavier than gas, falls to the bottom of the tank and removed for additional treatment or sent to the storage tanks. The lighter element, gas, is removed from the top of the tank and enters the gas gathering system. Vertical and horizontal separators, which are more modern pieces of equipment, use forces in addition to gravity to achieve the best possible separation of well fluids.

Well fluids enter the vertical separator at about midpoint of the tank. Here, while they are swirled around, two forces work to separate the oil and gas: gravity causes the heavier oil to drop to the lower part of the separator, and the whirling action causes the heavy oil particles to collect on the walls of the separator. The gas, which still contains some oil particles, rises through the chamber where it is again swirled, and the same forces operate to remove

STUDENT REFERENCE (continued):

more oil. The gas then rises again and passes through the scrubber dome where the last oil particles are removed. After this final process, the gas is removed through the gas outlet near the top of the separator, and the heavier oil is removed through and outlet at the bottom of the separator.

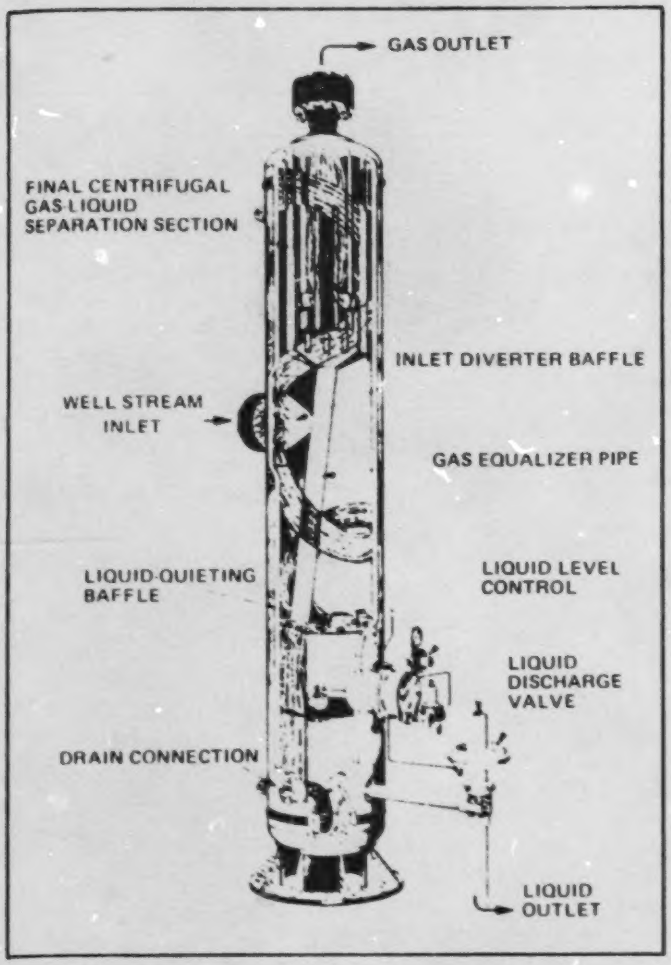
A horizontal separator operates in much the same way as a vertical separator, though, as the name implies, the unit is horizontal instead of upright. The same forces of gravity and swirling action are employed, and the oil is removed from the bottom of the unit and the gas from the top.

Horizontal separators may be of either the single-tube or the double-tube design. The double-tube horizontal separator has two horizontal units mounted one above the other and joined by flow channels near the ends of the units. The well fluids enter at one end of the upper unit and are swirled, and the liquids fall through the flow channel and joins the gas stream leaving the upper separator at the gas outlet. Oil is discharged through a connection at the lower part of the bottom tube.

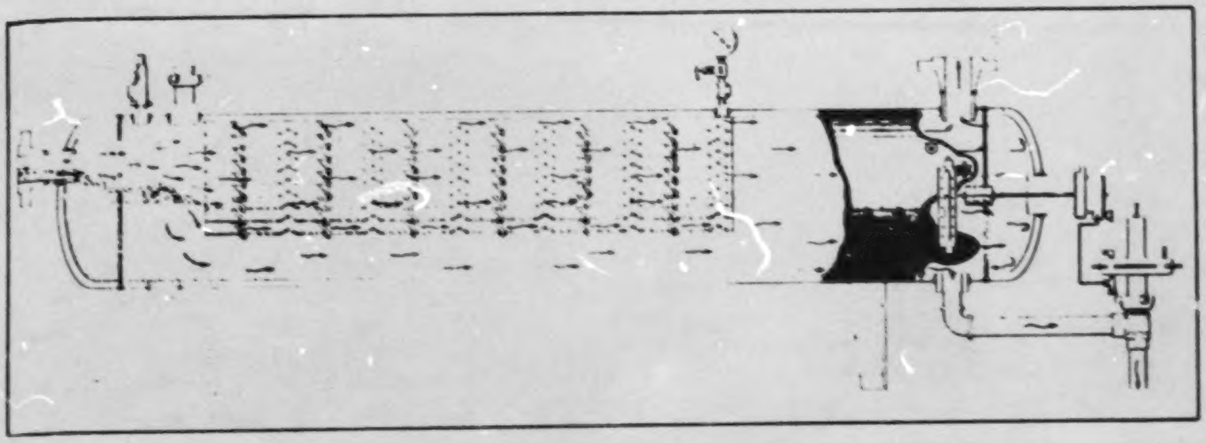
In order to obtain more complete recovery of liquids, more than one stage of separation is often desirable. When two-stage separation is used, the well fluids pass through either a vertical or horizontal separator for the first stage of separation. The liquid resulting from this stage is then sent into a second separator that operates at a lower pressure, and more gas is removed from the liquid. Any number of separators may be used in stage separation as long as each stage operates at successively lower pressures.

A low-temperature separation method is used to handle the production from high-pressure gas wells. These wells usually produce a mixture of gas and some light liquids, which must be separated. The removal of water vapor from gas, which is known as dehyrdration, is important because many pipeline companies will not buy gas containing more than 7 pounds of water per million cubic feet of gas.

The low-temperature separation methods uses the cooling effect of expanding high-pressure gas. As the well stream enters the separator at nearly wellhead pressure and moves through a series of coils and an adjustable choke, it expands and cools, allowing the liquids (both condensate and water) to drop to the bottom of the separator. The resulting dry gas is taken out of the separating cycle and


GAS OUTLET
FINAL CENTRIFUGAL GAS-LIQUID SEPARATION SECTION
INLET DIVERTER BAFFLE
WELL STREAM INLET
GAS EQUALIZER PIPE
LIQUID-QUIETING BAFFLE
LIQUID LEVEL CONTROL
LIQUID DISCHARGE VALVE
DRAIN CONNECTION
LIQUID OUTLET

VERTICAL SEPARATOR



HORIZONTAL SEPARATOR

STUDENT REFERENCE (continued):

moved to the heat exchanger where it is warmed by the well stream; it then moves into the gas gathering system. The condensate goes to a low-pressure vessel, and the wastewater moves into the disposal system.

EVALUATION:

Answer the following questions in writing:

1. Why are separators necessary?
2. What force is used in the separator liquids from the gas?
3. What are the storage tanks used for?
4. Why will the oil come out the bottom and the gas from the top of a separator?
5. How many separators can be used?

## VI. DUTY: Well Completion

### TASK 7: Build a Transmission Line

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**INTRODUCTION:**

In this lesson the size and method of transporting gas from the wellhead to the home will be explored.

**LEARNING ACTIVITIES:**

1. A classroom slide presentation "Million Mile Network" will be attended.
2. Classroom discussion of meters, compressor station, gas pressure and the safety precautions to be observed when working near pipeline will be held after the above presentation.
3. Read the student reference material and write 3 questions about the material you do not understand.

**STUDENT REFERENCE:**

The most efficient transportation system of today is natural gas moving the vast network of pipelines on its way to your home. This transportation system is as efficient as it is far reaching. This system is comprised of an elaborate network of 1 million mile of pipeline that connects the nations more than 47.6 million customer of natural gas utilities. Natural gas travels this million mile network to homes, schools, hospitals, offices, and giant manufacturing facilities. All natural gas users are served by this grid of pipeline that covers about the same distance as 23 times the entire United States interstate highway system. And that has the capacity to carry 23 to 24 trillion cubic feet of gas per year. The million mile network is the artery system of the natural gas industry. Gas travels through pipelines much like blood travels through your body with compression keeping the gas flowing much as your heart keeps your blood flowing. Because of the quiet, efficient, strong energy system performed, it functions underground where you can neither see or hear it; it is sometimes taken for granted.

STUDENT REFERENCE (continued):

Once gas has been successfully drilled the drilling rig is removed from the well site and a christmas tree is put in its place capping the well. A christmas tree is a collection of vavles at the wellhead that serves various purposes such as pressure reduction or production rate control. These valves start the gas on its trip across the country.

The pipelines that carry gas directly from the well to the main truck pipeline are called field and gathering lines which make up 7% of the million mile network. As gas moves through these fields and gathering lines, it is usually pushed along by its own natural pressure as it enters the case of the well with a low reservoir of pressure, gas is drawn by suction to increase its flow and thus the productivity of the well. As it makes its way through the system the gas rubs against the sides of the pipeline building up friction. This small amount of friction adds up and the gas begins to slow down. This is one place compressor stations become necessary. Compression engines are needed to get the gas from the gathering lines to its next destination in the transmission system.

Transmission lines make up about 1/4 of the million mile network. They are normally made of steel, they carry the gas to one of two places, either the distribution system or to a large volume customer. They operate at higher pressure than other pipelines, are longer than other portions of the network and the distance between connections is greater than other pipelines.

If the gas is going to travel a long distance through the transmission system it may have to pass through several compressor stations before it reaches the next segment of the network.

These compressors which aid the gas in its movement from the gathering to the transmission system, as well as in its journey to the transmission lines in either piston type or turbine type engines. They perform their function efficiently with most of the compressors themselves operating on natural gas. Taking their fuel from the very pipeline they are pushing gas through.

When the compression process is completed, the gas under increased pressure moves ahead on its journey to one of two places. First, it may be put in storage until it is again

STUDENT REFERENCE (continued):

with aid of compression, into the transmission system. But if the gas is needed at once it will enter the distribution system, the transportation system that will deliver the gas to your home. This system will make up 2/3's of the million mile network.

Before the natural gas enters the gas distribution mains, it passes through a regulator or border station. As it moves through the border station, instruments tell how much gas is flowing into the community. There are also regulator valves that lower the pressure of the gas, as it goes through the regulator valve the gas expands increasing the volume and the pressure drops.

From the regulator station gas moves into the beltline around a city. It then passes through gas mains under the streets to a line station where its pressure is reduced to less than one pound. This is the pressure that gas enters the service line to your home.

A factory might need to take the gas at its beltline pressure in order to meet its manufacturing process requirements. It might have the gas pass through an industrial station to adjust the pressure to meet its demands.

A house being serviced by natural gas is located in an area not served by a city's gas distribution system. This customer will have a house regulator outside the dwelling to reduce the correct pressure before it passes through his meter.

When the gas reaches the meter outside the home, factory, school, hospital, it has reached the end of its travels through the million mile network.

EVALUATION:

Answer the following questions in writing:

1. What is considered to be the most efficient transportation system in America?
2. What is a christmas tree in the oil and gas industry?
3. What are field linss used for?

EVALUATION:

4. Why are compressor stations needed to move gas?
5. How much pressure is gas under when it enters a home?
6. Where might gas be stored?
7. What are regulator valves used for?
8. About how much gas can travel through America's pipeline system?
9. How is gas pushed through the field lines?
10. What fuel do compressors normally operate on?

## VII. DUTY: Employability

### TASK 1: Where to Begin

PERFORMANCE OBJECTIVES:

Going about getting a job in a very positive and organized matter is often the difference between the job being offered or not. This task and the ones that follow are arranged with resources and learning activities which will assist you in preparing to get a job.

LEARNING ACTIVITIES:

1. Take the "Pre-employment Test" (pink section) of the Employability Skills Mini-Course. Share your test results with your counselor or teacher and discuss your need to master the rest of the competencies.
2. Look over the "Pre-employment Check List" (blue section) of the Employability Skills Mini-Course. Obtain a Social Security number if you do not have one.
3. Read the Student Reference section of this module and answer the questions.
4. View the filmstrip/cassette.
5. Read Chapter 1, Dicie and Mylo Get Their Jobs.
6. You need to keep your own file of your job-seeking activities. Things that should be in your file are:

   (a) a list of your skills
   (b) a list of your interests
   (c) what you want in a job
   (d) where you can find a job
   (e) sample letter of application
   (f) your resume
   (g) information on job interviews
   (h) sample job application

LEARNING ACTIVITIES (continued):

7. If you have been in a vocational program, you have developed many occupational skills. A list of these skills is probably available from the class progress chart or your instructor's record book. Obtain a list of these and add any other useful skills you may have learned in or out of school. Have the list typed and put it in your file for use with prospective employers.

8. With your list of skills, develop a list of your interests. This will be for your reference as you look for a job.

STUDENT REFERENCE:

A review of your education, interests, and work experiences up to the present time will help you to make a good job choice. The following form is for your own reference so please take the time to fill it out as completely as possible. From it you should be able to spot your qualifications and identify the areas in which you excel.

KNOW YOUR QUALIFICATIONS

1. List in order of preference the job or profession at which you hope to be working five years from now:
    1.
    2.
    3.

2. Name three characteristics or requirements of the job or profession which you have chosen:
    1.
    2.
    3.

3. List five subjects, activities or projects in which you are strongly interested:
    1.
    2.
    3.
    4.
    5.

STUDENT REFERENCE (continued):

4. List three subjects in which you did your best work at school:
   1.
   2.
   3.

5. What are three qualities of your personality which you think are the best:
   1.
   2.
   3.

6. What are the three qualities of your personality which you think are the worst and could stand improvement:
   1.
   2.
   3.

7. List all skills you have and the machines you can operate and the level of proficiency. Include all certificates and licenses you have obtained:

   ______________________________________________

   ______________________________________________

   ______________________________________________

   ______________________________________________

EVALUATION:

Prepare a student file folder containing the following:

a. Social Security number b. Skills List
c. Interest List

VII. DUTY: Employability

## TASK 2: What Do I Want In A Job?

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PERFORMANCE OBJECTIVES:

There are lots of things about jobs that make them more or less desirable for you. Use the resources and learning activities to make yourself aware of the needs to be considered by you in getting a job that fits your skills and desires.

LEARNING ACTIVITIES:

1. Read about what to expect from a job in Chapter 2 of the booklet Dicie and Mylo Get Their Jobs.

2. Consider the many things about jobs that make them good, better or best for you. Discuss with other students (as a group or individually) the various things about a job that are important. Write out a "preference list" of all the things you want in a job such as working conditions, pay rate, fringe benefits, etc.

3. Talk with students and other people about your preference list and revise it as needed. Go over your list and circle the "preferences" that you feel are absolutely necessary.

EVALUATION:

1. Refine your "preference list" so that it is honest and reasonable. Add it to your job seeking file.

## VII. DUTY: Employability

### TASK 3: Where Can I Find A Job?

---

### PERFORMANCE OBJECTIVES:

A 1980 report from the U. S. Department of Labor covers a study in which thousands of job holders were asked how they found their employment. Here is what the job holders said:

> One percent found their employment through private employment agencies.
>
> Three percent successfully used public employment agencies.
>
> Five percent succeeded through help-wanted ads.
>
> Six percent got their jobs through school placement services.
>
> Twenty-four percent found their jobs through direct contacts with employers.
>
> Forty-eight percent found their jobs through friends or relatives.
>
> About 13 percent reported that they used a combination of the above techniques or other means to find employment.
>
> Use this material to become familiar with the best ways for you to find a job.

### LEARNING ACTIVITIES:

1. Look over the first green section of the Employability Skills Mini-Course on "Where the Jobs Are."
2. Review Student References on "Suggestions to Individuals Seeking Jobs."
3. Make a list of "the best ways for you to find a job."

LEARNING ACTIVITIES (continued):

3. Read Chapter 3 of the booklet Dicie and Mylo Get a Job on "How to Look for a Job." Revise your list as needed.

4. View the audio/filmstrip Getting Job Leads dealing with "sources for finding a job." Revise your list as needed.

5. Ask anyone who is employed for ideas for your "best ways to find a job" list. Particularly ask people doing the type job you would like to have. Revise your list as needed.

6. Compare your "best ways to locate a job" list with other students. See if you can improve their list and viceversa.

STUDENT REFERENCE:

Let the following people and agencies know what you're looking for in a job.

1. Tell relatives, friends, neighbors.
2. Tell your minister, rabbi, or priest, your doctor and dentist.
3. Alert local business people with whom you deal.
4. Get in touch with any employers for whom you have worked.
5. Examine the classified telephone directory for employer names.
6. Telephone prospective employers for interview appointments.
7. Pay personal visits to places of employment.
8. Send letters of application to likely employers.
9. Read classified ads (Help Wanted) in newspapers.
10. Register at the State Employment Security Office.
11. Register at private employment agencies.
12. Apply at local, state, and federal civil service offices.
13. Put "Situation Wanted" ads in daily and weekly newspapers.

EVALUATION:

1. When your "best ways to find a job" list has been completed to your satisfaction, add it to your file.

VII. DUTY: Employability

## TASK 4: How Do I Write A Letter Of Application?

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PERFORMANCE OBJECTIVES:

Once you know about a job you may be interested in, you need to contact the company. You may do this by phone or visit. Sometimes, however, you may have to write to them. The following resources and activities will help you put together a good letter of application.

LEARNING ACTIVITIES:

1. Read over the brown section of Employability Skills Mini-Course on "Letter of Application." Become very familiar with the pointers they give on writing the letter of application as well as the tips on punctuation and capitalization.

2. Using the pointers, tips, and sample letters from the "Mini Course" write a letter of application to a company advertising in the newspaper want ads.

3. Read Chapter 4 of the comic book Dicie and Mylo Get a Job on writing a letter of application. Revise your letter as needed.

4. Have an English teacher review your letter and help you improve it.

STUDENT REFERENCE:

### STEPS TO FOLLOW IN WRITING A LETTER OF APPLICATION

1. Be brief and to the point--rarely more than one page in length, neatly typed on high grade bond paper or neatly printed.
2. Address your application to a specific person whenever possible.
3. The opening paragraph should explain why you are writing and the specific job or field of work for which you are applying. State the source from which you found the job advertisement.

STUDENT REFERENCE (continued):

4. The body of the letter should include your personal qualifications and how your training will meet their needs.
5. If you are a beginner, say so, adding that you are anxious to find a place to start and that you will work hard to succeed.
6. In your final paragraph make your request for an appointment.
7. Include a personal data sheet with your letter.

## A LETTER OF APPLICATION

If you read an advertisement about a job, you may decide to answer it and apply for the position through a letter. You may also decide to use this method if you want to be considered by a particular firm, or if someone has told you the company is looking for qualified people.

The business letter you send to apply for a job is your direct contact with your prospective employer. You will be judged by the letter you write, since you are not there in person. For this reason, the letter should present an honest, yet impressive, appraisal of yourself.

If you were applying for a job in person, you would dress neatly and appear well-groomed and polite. Your letter of application can make this same impression. Write or type it carefully, checking spelling, punctuation, grammar and accuracy. Give the employer the information needed to judge your qualifications and abilities, but do not wander from the point and waste words in idle chatter. Tell how you heard about the job and why you are interested in it. Provide all the data needed to get in touch with you if the employer is interested in talking with you.

Study the following sample letter:

STUDENT REFERENCE (continued):

451 Neat Street
Big Ugly, WV 25011
Date

Mr. Robert Jones, President
Jones Manufacturing Company
1400 Main Avenue
Cleveland, WV 25000

Dear Mr. Jones:

Please consider my application for the position of typist which was advertised in the Press. I have just graduated from Homes High School where I took a business education course. I have studied typing for two years and can type accurately at the rate of 60 words per minute.

In addition to my business education, I have held several part-time jobs that have provided experience in this field. I worked as a clerical helper with light typing duties for the Marco Company during the past two summers. I also addressed envelopes on a part-time basis for the Sims Mailing Company for a period of six months last year.

I would appreciate an opportunity to discuss this job with you at your convenience. You may contact me by mail at the address above or telephone me at 926-1234.

Sincerely yours,

Mylo Baggins
(Type or print name here)

EVALUATION:

1. When you are satisfied that your letter of application is well written and conforms to the suggestions in the resources, add it to your file.

VII. DUTY: Employability

TASK 5: How Do I Prepare A Resume?

## PERFORMANCE OBJECTIVES:

The resume (personal data sheet) is actually a worksheet that simply states personal facts about yourself. Completing a resume helps pull from your mind and records the information necessary to advertise yourself to prospective employers and to fill out job applications. Use the following resources and learning activities to develop your own resume.

## LEARNING ACTIVITIES:

1. Read about the resume in Chapter 5 of Dicie and Mylo Get Their Jobs.
2. Attend a discussion on the resume. Ask any questions you have that will enable you to get a clear picture of what a resume is and why it is important to you.
3. Read Student Reference "Recognizing the Importance of a Good Resume".
4. Look over the two sample resumes listed in the Student Reference, and using them as models, write out a resume of your own.
5. Read over the yellow section of Employability Skills and Mini-Course on "Resume, Cover Letter, and Billfold Card."
6. You now have a number of resume samples and your own resume. Review all the materials and "polish" your resume so that it is complete and reflects your style. Type or print it neatly and get copies made. Have a teacher or personnel director review it.

**STUDENT REFERENCE:**

## Recognizing the Importance of a Good Resume

What does a good resume do for you?

- It creates a favorable impression of you.

- It relates your availability to the needs of the employer.

- It focuses attention on your special abilities for the specific kind of job you want.

- It is attractive to the eye, yet dignified in appearance. In a pile of resumes, it stands a good chance of being among the first to be read and retained for further consideration.

- It fully covers the major strengths you will bring to the job and yet is not so long that employers will not find time to read it quickly.

- It creates the desire to meet you personally and to find out more about you.

- It helps to keep employers on the track during interviews.

- It fortifies your prospects for obtaining a job offer in the shortest possible time at the highest possible pay.

- It saves you much time and effort in completing company applications. With it, you can reduce that task to filling in only those blanks regarding experience not covered by your resume and insert "Please see the enclosed resume" for the rest. (Given this approach, hiring officials tend to ignore the official application and simply review your resume--a far more compelling statement of your qualifications than most applications allow.)

In short, your resume has one chief aim - to produce interviews with employers who are predisposed to look favorably on your qualifications. Or, if submitted after an interview, "firm up" a job offer.

STUDENT REFERENCE (continued):

## PERSONAL DATA RESUME

Sample

NAME: Larry S. McNinch

AGE: 18

ADDRESS: 1747 Third Street
Moundsville, West Virginia 26041

OCCUPATION: Student HEALTH: Excellent

TELEPHONE: 304-555-0000 MARITAL STATUS: Single

TYPE OF WORK DESIRED: Automotive Services/Mechanical

SCHOOLS ATTENDED: Sanford Grade, Moundsville, West Virginia
Moundsville Junior High, Moundsville, West Virginia
John Marshall High School & Vocational Center, Glen Dale, West Virginia, graduated June 1980

SUBJECTS: Automotive Services - 2 years
Pre-Vocational Cluster - 1 year
Business Mathematics - 1 year
General high school requirements for graduation in June.

EXPERIENCE: In-school experience, Auto Service Lab
Worked part time during school at Ron's AMOCO, Moundsville, West Virginia
Worked in Governor's Summer Youth "Clean Streams" Program

ACTIVITIES: Member of VICA Youth Organization (Vocational Industrial Clubs of America)
Contestant in the Plymouth Trouble Shooting Contest - 2 years

HONORS AND AWARDS: 1st place - Plymouth Trouble Shooting Contest - 1978
Received Elks Vocational Scholarship Award - 1979

## STUDENT REFERENCE (continued):

SPECIAL SKILLS: Operation of the following equipment:
Sun -620 Generator Alternator Tester
John Bean Visualiner Alignment
Sun -1020 Electronic Diagnosis Engine Tester and Performance Tester
Dynamometer
Brake Drum Grinding and Turning
Wheel Balancing

REFERENCES: (by permission)
Mr. Robert Thomas, Teacher & Advisor, Automotive Services, John Marshall High High School & Vocational Center, Glen Dale, West Virginia 26038.
phone 304-555-0000.

Mr. Fred Oelschlager, Vocational Placement Coordinator, Marshall County High School, Glen Dale, West Virginia 26038. phone 304-555-0000.

Mr. James Dickinson, Personnel Director, Ohio Valley Medical Center, Wheeling, West Virginia 26003.
phone 304-555-0000.

## SAMPLE RESUME

Miss Dillie Pinson
33 Gilmer Street, S. E.
Huntington, West Virginia 25701
Phone: 736-0000
Social Security No.: 222-00-0000

Type of work desired: Clerk Typist
Date: April 5, 1974

## PHYSICAL CHARACTERISTICS

Age: 16 (Date of birth: 2-13-58)
Health: Excellent

## STUDENT REFERENCE (continued):

## EDUCATION

| School | Dates of Attendance |
|---|---|
| Pea Ridge Elementary School | September 1965 to June 1970 |
| Barboursville Junior High School | September 1970 to June 1973 |
| Barboursville Senior High School | September 1973 to present |

## COURSES TAKEN THAT MIGHT BE HELPFUL IN THIS POSITION

Typing I General Business Psychology

## WORK EXPERIENCE

Summer 1973: Waitress at Ladona's
Employer: Mr. H. Harmon
2261 Dixie Road
Huntington, West Virginia 25701

## REFERENCES

Mr. Arnold Lang
310 Brent Road
Huntington, West Virginia 25701

Phone: 523-0398
Occupation: Carpenter

Mrs. Barbara Wayne
7189 Cliff Valley Road
Huntington, West
Virginia 25701

Phone: 525-1029
Occupation: Housewife

## EVALUATION:

1. Your completed resume should conform to the standards in the resources. Add copies of your resume to your job seeking file.

VII. DUTY: Employability

## TASK 6: How Do I Complete A Job Application?

PERFORMANCE OBJECTIVES:

Job applications are a fact of life. If you are familiar with them and have a resume, they are relatively easy to complete. It is important to fill them out neatly and correctly. Use the following resources and learning activities to become acquainted with application forms, and practice filling them out.

LEARNING ACTIVITIES:

1. Read Dicie and Mylo's chapter 6 filling out a job application.
2. View the filmstrip/cassette on filling out a job application. Take notes.
3. Look over the orange section of the Employability Skills Mini-Course on the "Job Application."
4. Review Student References. Notice how the various blank application forms are laid out.
5. Select one of the blank application forms and fill it out. You may need to review some of the resources again to get everything filled out correctly.
6. Look at the other blank application forms and notice any items that were not included on the one you filled out. Be sure you know how to complete these items.

**STUDENT REFERENCE:**

## SELL YOURSELF - JOB APPLICATION

### RULES

(a) Remember, you are trying to sell yourself by the information you give--be honest and accurate.
(b) Look over the entire application form before you begin. (Watch for special instructions to print or write in own handwriting.)
(c) Follow instructions carefully and exactly.
(d) Use ink unless otherwise requested.
(e) Write or print neatly and legibly.
(f) If you should make an error, mark through it with one neat line and write correct response above it.
(g) Keep answers brief but precise.
(h) Fill in all blanks - (1) when question doesn't pertain to you write N/A.
(i) Know complete name, address, titles, and phone numbers of all references and former employers - confirm with all references your intent to use them.
(j) In box for salary expected - try to use amount you expect - if you don't know what is appropriate - write "open" or "scale".
(k) Be sure you include all special abilities or accomplishments you may have.
(l) When finished, check form for completeness, accuracy and correct spelling.

The following pages will give you an opportunity to complete a sample application form. Remember the rules listed above.

## TERMS TO KNOW TO FILL OUT A JOB APPLICATION

1. NATIONALITY--county where a person is born.
2. GUARDIAN--person in charge of the legal care of a youth.
3. MARITAL STATUS--single, married, divorced, or widowed.
4. NUMBER OF DEPENDENTS--individuals who depend upon you for their support.
5. ETHNIC GROUP--caucasian (white), negroid (black), Indian, Asian, other.
6. LIMITATIONS--health or physical condition that may hinder a person on the job.

STUDENT REFERENCE (continued):

7. CAPABILITIES--things you do well.
8. COMPENSATION--pay for time not able to work.
9. NATURALIZED CITIZEN--a person not born in this country who has gone through the legal process to become a citizen.
10. NATURAL BORN CITIZEN--a person who is born in a country.
11. FRINGE BENEFITS--things given an employee other than money.
12. WAGE--the hourly rate of pay.
13. SALARY--monthly or yearly contract payments.
14. SUPERVISOR--someone in charge of other workers in a company.
15. EMPLOYEE--a person who works for another person or company.
16. EMPLOYER--a person or company who hires another.
17. O.A.S.I.-- Old Age Survivors Insurance.
18. DEDUCTION--that which is taken from a pay check.
19. FEDERAL WITHHOLDING--tax money taken out for the U.S. government.
20. STATE WITHHOLDING--tax money taken out for the State government.
21. ANNUITY--a form of saving money.
22. GROSS PAY--the total amount before deductions.
23. TAKE HOME PAY--the amount that is taken home.
24. MANAGEMENT--those who make decisions.
25. PERSONNEL MANAGER--person who is in charge of hiring people.
26. JOB INTERVIEW--the person-to-person contact between employee and prospective employer.
27. F.I.C.A.--(Federal Insurance Compensation Act)--money taken out for Social Security.

## STUDENT REFERENCE (continued):

Please fill out in your own handwriting.

### PERSONAL INFORMATION

Name in Full ______________________________ Date ______
(Last) (First) (Middle)

Social Security Number ______________________________

Present Address ______________________________ Phone No. ______

Permanent Address ______________________________ Phone No. ______

Place of Birth ____________ General Physical Condition ______

Any physical impairments? _____ If so, describe ____________

______________________________________________

Job Applying For ______________________________

Do you own a car? _____ Make and Year ______________________

Where would you prefer to live? ______________________

Why? ______________________________________

Are you willing to travel? ____ Occasionally ____ Frequently ____

Constantly _____

Have you ever worked for this company? ______________________

When & Where ______________________________

At what salary do you expect to start? ______________________

To be earning five years from now? ______________________

### PERSONAL REFERENCES

| | Name | Address | Occupation |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

## STUDENT REFERENCE (continued):

### EDUCATIONAL BACKGROUND

Elementary School________________________________________

_________________________________________________________

High School______________________________________________

_________________________________________________________

Trade/Business___________________________________________

_________________________________________________________

College or University____________________________________

Others___________________________________________________

What did you specialize in at school?____________________

What did you specialize in at college?___________________

### MILITARY RECORD

Dates in Service: From____________ To____________________

Branch________________________ Final Rank________________

Special Training______________ Present Status____________

**EXPERIENCE** - (Past 10 years - list last job first - Account for all periods of unemployment)

Name of Organization__________________ Job Title___________

Address_______________________________ Salary______________

Dates of Employment: From______________ To__________________

Name of Supervisor__________________________________________

Complete description of work you did________________________

____________________________________________________________

Reason for leaving__________________________________________

STUDENT REFERENCE (continued):

FOR COMPANY USE ONLY
Date Received:
Referral Source: ____

## APPLICATION FOR EMPLOYMENT

Date ________ Position applied for ________________

Name ____________________ Social Security No. ________

Address ____________________ Phone No. ________
(Street or RFD) (City) (State)

Previous Address ____________________________

Have you ever worked for this company before? ________

Where? ________ When? ________

MILITARY RECORD;

Dates in Service: From ________ To ________

Branch ________________ Final Rank ________

Special Training ________ Present Status ________

Comments: ____________________________

____________________________________

Interested in: Temporary work ___ Full-time ___ Part-time ____
Saturday only ___

Salary expected ______ Are you responsible for your entire support? ______

Nature of any physical defects ________________

Recent illnesses ____________________

Date of last physical examination ________________

STUDENT REFERENCE (continued):

| Education | Circle grade completed | Name of School | Location | Major Subject | Year Graduated |
|---|---|---|---|---|---|
| Elementary | 1 2 3 4<br>5 6 7 8 | | | | |
| High School | 1 2 3 4 | | | | |
| Business or Vocational | 1 2 3 4 | | | | |
| College or University | 1 2 3 4 | | | | |
| Night or Correspondence | 1 2 3 4 | | | | |

Give details of any other educational training_______________

____________________________________________________________

What are your hobbies?________________________________________

In case of illness or emergency, notify:

Name______________________________Relationship_______________

Address___________________________Phone No.__________________

Why do you feel qualified for the position for which you are applying?_____________________________________________

____________________________________________________________

____________________________________________________________

STUDENT REFERENCE (continued):

## PREVIOUS EMPLOYMENT
(Last employment first)

| From | To | Name/ Address Employer | Dept., duties, salary | Reason for leaving |
|---|---|---|---|---|
| Month<br>____<br>Year<br>____ | Month<br>____<br>Year<br>____ | | | |
| Month<br>____<br>Year<br>____ | Month<br>____<br>Year<br>____ | | | |
| Month<br>____<br>Year<br>____ | Month<br>____<br>Year<br>____ | | | |
| Month<br>____<br>Year<br>____ | Month<br>____<br>Year<br>____ | | | |

## PERSONAL REFERENCES
(Do not give names of relatives or former employers)

| | Name | Address | Occupations |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

STUDENT REFERENCE (continued):

FOR COMPANY USE ONLY
Date received______
App. No.______
Renewal Date(s)______
Referral Source,
if any______

Type of Employment
_____Regular ____Part Time

DATE: JOB FOR WHICH YOU ARE APPLYING:

| | | | | |
|---|---|---|---|---|
| | Last | First | Middle | Soc. Sec. No. |
| PRINT NAME | | | | |
| | Number | Street | City | Zip | Phone No. |
| ADDRESS | | | | | |

Physical defects, if any that would affect your ability in the position applied for

Any health conditions that would affect your ability in the position applied for

Have you taken a physical examination recently? ____Yes ____No If so, When?_____

Have you had any illnesses in the past five years? ____Yes ____No

Branch of Service: Service No.: Present Draft Status:

Highest Rank Attained Period in service From: To: Reserve Status

LIST BELOW THREE REFERENCES (NOT FORMER EMPLOYERS OR RELATIVES):

| Name | Address (St., City & State) | Phone Number | Name of Employer |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

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STUDENT REFERENCE (continued):

## EDUCATION

| | SCHOOL | LOCATION | NAME OF COURSE | LAST YR. COMPLETED | GRAD. | DEGREE |
|---|---|---|---|---|---|---|
| GRAMMAR SCHOOL | | | | | | |
| HIGH SCHOOL | | | | | | |
| COLLEGE | | | | | | |
| TRADE, BUS. OR CORRES. | | | | | | |

Do you Type ____Yes ____No Speed: Do you take Shorthand ____Yes ____No Speed:

Office Machines Operated Do you read Blueprints ____Yes ____No

Shop Machines Operated What tools or equipment do you have?

Have you served apprenticeship or attended vocational training courses Craft?________ Time Served_____ School or Company_____

Give past employment record completely, starting with present, or last employer, then each previous employer in date order. Include any civil service and reason for lapses, if any.

| Company Name | Address | Dates | Rate of Pay | Duties Performed | Reason for Leaving |
|---|---|---|---|---|---|
| | | From<br>To | | | |
| | | From<br>To | | | |
| | | From<br>To | | | |
| | | From<br>To | | | |
| | | From<br>To | | | |
| | | From<br>To | | | |

If now employed why do you desire to change? Salary or Wage Expected Per Month Week Hour

STUDENT REFERENCE (continued):

| | |
|---|---|
| What forms of recreation do you enjoy? | What transportation to work? |

I Hereby Certify that the entries on this form and the statements made by me are true and correct. If employment is obtained under this application, I will cheerfully comply with all orders, rules, and regulations of the employer. I agree to submit to physical examination. I also authorize my former employers and other individuals to give any information concerning me, whether or not it is on their records; and I hereby release them and their companies from any liability whatsoever. I understand that I will be subject to dismissal if anything in this application is found to be untrue.

| | |
|---|---|
| DATE | SIGNATURE OF APPLICANT |

DO NOT WRITE BELOW THIS LINE

| | | |
|---|---|---|
| DATE | INTERVIEWED BY | JOB SUITED FOR |

| | | | | |
|---|---|---|---|---|
| Approved By | Date employed | Dept. | Job | Rate $ |

STUDENT REFERENCE (continued):

APPLICATION FOR EMPLOYMENT ______________________________
(Employer)

Name in Full ______________________ Soc. Sec. No. __________
(Last) (First) (Middle)

Position Applied For ______________________________

Home Address ______________________ Phone No. __________

Are you a citizen of the U.S.? Yes____ No____

If not a citizen, do you have proof of right to work or for permanent residence in the U.S.? Yes____ No____

Are you under 18? Yes____ No____

Are you over 69? Yes____ No____

EDUCATION

Circle highest grade completed:
0 1 2 3 4 5 6 7 8 9 10 11 12 Above

| School | Name and Address | Degree or Certif. |
|---|---|---|
| High School | | |
| College | | |
| Business or Vocational Schools | | |
| Additional Training | | |

PROFESSIONAL AND CHARACTER REFERENCES (other than relatives)

| Name | Address |
|---|---|
| | |
| | |
| | |

STUDENT REFERENCE (continued):

WORK HISTORY: Describe Your Longest and Most Important Jobs - Including Military Service - Begin With Most Recent

Name of Employer

Job Title-Responsibilities-Tasks Performed-Machines Operated-Tools Used

Address

Type of Business

From To Wage

Reason for Leaving

Name of Employer

Job Title-Responsibilities-Tasks Performed-Machines Operated-Tools Used

Address

Type of Business

From To Wage

Reason for Leaving

Name of Employer

Job Title-Responsibilities-Tasks Performed-Machines Operated-Tools Used

Address

Type of Business

From To Wage

Reason for Leaving

STUDENT REFERENCE (continued):

__________________________________________________________

Summary of Other Work

__________________________________________________________

__________________________________________________________

Have you ever worked for this company under a different name?____________ If "yes", explain below:

I authorize investigation of all statements contained in this application.

Date______________________

__________________________
Applicant's Signature

## VII. DUTY: Employability

### TASK 7: How Do I Get Ready For A Job Interview?

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PERFORMANCE OBJECTIVES:

A job interview should be a very pleasant and informative experience. How you act and how the interviewer acts will set the stage. The more familiar you are with the interview process, the more at ease you will be. Use the below learning experiences to become familiar with the interview process and practice the interview.

LEARNING ACTIVITIES:

1. Read the Job Interview chapter 7 to see how Mylo and Dicie prepared for their interview.
2. View the filmstrip/cassette on The Job Interview. Take a few notes as needed.
3. Take the "Self Check Test," listed below and discuss the answers with your classmates.
4. Attend a presentation by an interviewer on the topic "The Job Interview." Take notes during the presentation.
5. Read the beige section on "The Job Interview", in the Employability Mini-Skills. On a separate sheet of paper, write an interview plan using the given outline.
6. Carefully read all information in Student References.
7. Make up a list of ten things to look for in a good interview to be used as a rating sheet.
8. Ask the teacher to role-play interviewing you in front of the class. Ask the class to constructively critique your performance. If availble, use a video tape recorder.

LEARNING ACTIVITIES (continued):

9. Participate in a teacher led discussion on how to interview for a job. Take notes.

10. Participate in mock interviews by friends from your community. Let them constructively critique you after the interview and take notes on your experiences, good points, and items that need improvement.

STUDENT REFERENCE:

## SELF-CHECK TEST

1. Prior to an interview, a well-prepared applicant should:

    a. Rely on memory to answer or fill out any questions.
    b. Be prepared to answer questions by composing their own questions and answers.
    c. Answer all questions "off the top of the head."

2. For the interview, an applicant should:

    a. Wait for the interviewer to explain what the company's business is.
    b. Not worry about the company, just be interested in a specific job.
    c. Research the company.

3. In preparation for the interview, an applicant should:

    a. Locate the company prior to the interview.
    b. Leave early enough to find the company on the day of the interview.

4. Appropriate dress for an interview might be:

    a. Blue jeans and a shirt.
    b. Your best dress-up clothes.
    c. Clean, neat clothes appropriate to the company and the job you're applying for.

5. When an interview is scheduled for 10:00 a.m., the applicant should:

    a. Not worry about being ten (10) minutes late.
    b. Be punctual.
    c. Arrive an hour early.

STUDENT REFERENCE (continued):

6. When speaking with the interviewer, an applicant should:

    a. Emphasize good points.
    b. Tell the interviewer they didn't do so well in some skills or courses.
    c. Avoid the whole truth.

7. To answer any questions an interviewer might ask, an applicant should:

    a. Be honest, factual and sincere.
    b. Make up something if they don't know the answer.
    c. Lie if necessary to make a good impression.

8. If asked, "What can you do?" an applicant should:

    a. Avoid saying, "I'll do anything."
    b. Tell the interviewer, "It depends."
    c. Say, "I'll do anything."

9. When speaking to an interviewer, an applicant should:

    a. Try to look the interviewer in the eye.
    b. Read the pre-written paper.
    c. Look around the room.

10. An appropriate response to end an interview might be:

    a. "Thank you."
    b. "See you later."
    c. "Please pick me."

11. If applicants never hear from the company, they should:

    a. Never apply for another job.
    b. Tell friends never to apply there.
    c. Not be discouraged.

12. If applicants don't get the job, they should:

    a. Analyze why.
    b. Forget about the interview.
    c. Blame it on the interviewer.

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STUDENT REFERENCE (continued):

13. If applicants don't get the job, they should:
    a. Mourn.
    b. Keep trying.
    c. Be content to be unemployed.

No answers are provided for this self-check test. Instead, use each item as a discussion item with your instructor and class. Also, look for the correct answers as you complete the other Learning Activities for this task.

## SOME QUESTIONS FREQUENTLY ASKED DURING THE INTERVIEW

1. What are your future vocational plans?
2. In what school activities have you participated?
3. How do you spend your spare time? What are your hobbies?
4. In what type of position are you most interested?
5. Why do you think you might like to work at our company?
6. What jobs have you held? Why did you leave?
7. What course did you like best in school? Least? Why?
8. What do you know about our company?
9. Do you feel that you have received good general training?
10. Why do you feel that you will be successful in your field?
11. What extracurricular offices have you held?
12. Do you prefer any specific geographic location? Why?
13. How much money do you expect to earn at the age of 20? 35?

STUDENT REFERENCE (continued):

14. How did you rank in school?

15. Do you think that your extracurricular activities were worth the time devoted to them?

16. What personal characteristics are necessary for success in your field?

17. What are your parents occupations?

18. Are you looking for a permanent or temporary job?

19. Do you prefer working alone or with others?

20. Can you take instructions without feeling upset?

21. Tell me a story.

22. Are you primarily interested in making money, or do you feel that service to your fellowman is satisfactory pay?

23. Can you get recommendations from previous employers?

24. What interests you about our products and services?

25. Do you feel you have done the best scholastic work of which you are capable?

26. Have you ever had any trouble getting along with fellow students?

27. Do you like routine work?

28. What size city do you prefer?

29. What is your major weakness?

30. Will you work hard to get ahead?

31. Are you eager to please?

32. What do you do to get in good physical condition?

33. Have you had serious illnesses or injuries?

34. Are you willing to relocate if the company wishes?

## STUDENT REFERENCE (continued):

35. What job in the company would you like most to have?

36. Is it difficult for you to get along with people who have different backgrounds and interests than you?

37. Should an employer consider your grades? Why?

38. Would you be willing to work overtime?

39. What have you done that indicated initiative and a desire to work?

40. You have a complaint about your working condition. How would you handle it?

41. You and a fellow worker are having differences about your job. What would you do?

42. You have an idea you feel will help the company. What would you do?

## CHECK LIST TO BE USED BEFORE GOING FOR AN INTERVIEW

| | | Yes | No |
|---|---|---|---|
| 1. | Did I plan ahead for the interview? | ___ | ___ |
| 2. | Am I nervous when I meet people? | ___ | ___ |
| 3. | Do I ask intelligent questions? | ___ | ___ |
| 4. | Do I become tense when asked questions? | ___ | ___ |
| 5. | Am I highly emotional? | ___ | ___ |
| 6. | Do I take pride in my appearance? | ___ | ___ |
| 7. | Do I listen when someone else is talking? | ___ | ___ |
| 8. | Do I look at the speaker? | ___ | ___ |
| 9. | Do I practice good posture? | ___ | ___ |
| 10. | Do I use proper English? | ___ | ___ |
| 11. | Do I think before answering? | ___ | ___ |
| 12. | Do I answer honestly? | ___ | ___ |

STUDENT REFERENCE (continued):

## INFORMATION SHEET

### Negative Factors Evaluated During the Employment Interview and Which Frequently Lead to Rejection of the Applicant

1. Poor personal appearance.
2. Overbearing--overaggressive--conceited "superiority complex"--"know-it-all."
3. Inability to express himself clearly--poor voice, diction, grammar.
4. Lack of planning for career--no purpose and goals.
5. Lack of interest and enthusiasm--passive, indifferent.
6. Lack of confidence and poise--nervousness--ill-at-ease.
7. Failure to participate in activities.
8. Overemphasis on money--interest only in best dollar offer.
9. Poor scholastic record--just got by.
10. Unwilling to start at the bottom--expects too much too soon.
11. Makes excuses--evasiveness--hedges on unfavorable factors in record.
12. Lack of tact.
13. Lack of maturity.
14. Lack of courtesy--ill mannered.
15. Condemnation of past employers.
16. Lack of social understanding.
17. Marked dislike for school work.
18. Lack of vitality.
19. Fails to look interviewer in the eye.
20. Limp, fishy hand-shake.
21. Indecision.
22. Unhappy married life.
23. Friction with parents.
24. Sloppy application blank.
25. Merely shopping around.
26. Wants job only for short time.
27. Little sense of humor.
28. Lack of knowledge of field of specialization.
29. Parents make decisions for him.
30. No interest in company or in industry.
31. Emphasis on who he knows.
32. Unwillingness to go where we send him.
33. Cynical.
34. Low moral standards.
35. Lazy.
36. Intolerant--strong prejudices.

STUDENT REFERENCE (continued):

37. Narrow interests
38. Spends much time in movies.
39. Poor handling of personal finances.
40. No interest in community activities.
41. Inability to take criticism.
42. Lack of appreciation of the value of experience.
43. Radical ideas.
44. Late to interview without good reason.
45. Never heard of company.
46. Failure to express appreciation for interviewer's time.
47. Asks no questions about the job.
48. High pressure type.
49. Indefinite response to questions.

## QUESTIONS FOR THE INTERVIEWER AND INTERVIEWEE

Employer:

1. Why do you want this particular job?
2. How long do you intend to work?
3. Is there anything you would like to know about our company?
4. How did you know about this company and this job?
5. Do you know anyone who works here?
6. How far do you think this job can take you?
7. What salary do you expect?
8. What kind of grades did you make in school?
9. What were your favorite subjects in school?
10. What were your extra-curricular activities?
11. How do you spend your spare time?
12. What do you hope to be doing five or ten years from now?
13. Do you have any immediate wedding plans? How long do you plan to work?
14. What are your hobbies?
15. What books have you read recently?
16. How many days have you been absent from school this year?
17. What makes you think you can do the job for us?
18. Do you attend church?
19. Have you saved any money?
20. Do you have any debts?
21. Tell me about your home life during the time you were growing up.

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STUDENT REFERENCE (continued):

22. Do you live with your parents? Which of your parents has had the most profound influence on you?
23. Do you like to travel?
24. What types of people seem to "rub you the wrong way?"

Please note that employers are not legally permitted to ask some of the above questions. However, they are included for your discussion and awareness.

Employee

1. Exactly what will I be expected to do on this job?
2. For whom would I be working?
3. How much on-the-job training will I need?
4. What are the working hours? Are there any breaks? How long is lunch?
5. What are my chances for advancement?
6. What are the firm's promotional policies?
7. Will I need more education if I remain with the firm? If so, does the firm pay the expenses?
8. Do you have a company handbook?
9. Does the company offer any fringe benefits, i.e., health and accident insurance, life insurance, dental plan?
10. What is the company policy on dress?
11. What is the starting salary? (mention at end if employer does not)

## VII. Duty: Employability

### Task 8: Be Aware of Working Conditions

### INTRODUCTION:

In this lesson, you will explore the working conditions which you might encounter while on a rig such as the hours, weather conditions, and remote locations.

### LEARNING ACTIVITIES:

1. You will attend class presentation by a local drilling company in which hours, work shifts, weather conditions, and drilling locations will be covered.
2. Take notes during the presentation and prepare at least two questions to be answered in class.
3. Read and study the student reference material.
4. Answer the questions in the evaluation section of this lesson.

### STUDENT REFERENCE:

The people who work on today's rigs are responsible for the safe and efficient operation of millions of dollars worth of complex equipment. The work is not always easy - the weather can be terrible, the location is often remote, the hours long, and an element of danger exists. Nevertheless, for those who can qualify, drilling is an exciting, dynamic, and rewarding field.

### WORK SHIFTS

Unlike the company man and tool pusher on land rigs, the driller, derrickman, and rotary helpers do not work around the clock. Instead, they work in eight-hour shifts called tours (pronounced "towers"). Since drilling goes on twenty-four hours a day, seven days a week, there are usually four crews. The morning or daylight tour may work from 6:00 A.M. to 2:00 P.M., the afternoon or evening tour from 2:00 P.M. to 10:00 P.M., and the graveyard or midnight tour from 10:00 P.M. to 6:00 A.M. These hours can vary, depending on the individual contractor's policy, which is set according to the manpower he has available. Usually,

## STUDENT REFERENCE (continued):

the three tours will work five or six days a week and get two days off. The fourth crew fills in as needed for the crew taking its days off. This too may vary. For example, in some areas two crews work twelve-hour tours. Also, they usually work seven days, have seven days off, work seven more days, and so on, alternating with another crew.

### TRAINING

The people who work on drilling rigs come from a variety of backgrounds. The tool pusher usually attains his supervisory position only after years of experience working on rigs. Most likely he started out as a rotary helper (called a roughneck in the old days), advanced to derrickman, then to driller, and after working as a driller for a number of years, was promoted to tool pusher when the contractor had an opening.

The new hand on a rig starts out as a rotary helper, whose first job is mainly to watch and listen. If he is lucky (and today most are), he works under a driller who patiently explains and works with him until he is able to competently perform the tasks on hand. The more experienced rotary helpers also help the newcomer learn how to safely do his job. In addition, many contractors have established training programs for new rig hands, in which practical work experience on the rig is combined with classroom work.

## EVALUATION:

Answer the following questions in writing:

1. What is a tour?
2. What is a graveyard tour?
3. At what job does a new man usually start?
4. How can you become a tool pusher?
5. What will be the first job of the rotary helper?
6. How many hours each day would you expect the rig to run?
7. How many tours do most rigs have?

# GLOSSARY

## A

Abandon - to cease producing oil and gas from a well when it becomes unprofitable. A wildcat well may also be abandoned after it has proven nonproductive. Several steps are involved in abandoning a well: part of the casing is removed and salvaged; one or more cement plugs are placed in the borehole to prevent migration of fluids between the different formations penetrated by the borehole; and the well is abandoned.

Acid fracture - to part or open fractures in productive, hard-limestone formations by using a combination of oil and acid or water and acid under high pressure.

Acidize - to treat oil-bearing limestone or dolomite formations, using a chemical reaction with acid, to increase production. Hyudrochloric or other acid is injected into the formation under pressure, bringing about an enlargement of the pore spaces and passages through which the reservoir fluids flow. The acid is held under pressure for a period of time and then removed; finally, the well is put into production. Chemical inhibitors combined with the acid prevent corrosion of the pipe.

Adjustable choke - a special valve in which a conical needle and seat vary the rate of flow.

Air-actuated - powered by compressed air, as the clutch and brake system in drilling equipment.

Air drilling - a method of rotary drilling that uses compressed air as the circulation medium. The conventional method of removing cuttings from the wellbore is to use a flow of water or drilling mud. Compressed air removes the cuttings with equal or greater efficiency. The rate of penetration is usually; increased considerably when air drilling is used.

American Petroleum Institute - founded in 1920; national oil trade association which maintains a production department with offices in Dallas, Texas. The API is the leading standardizing organization on oil-field drilling and producing equipment, having published a great many codes covering such matters. It also has departments in Washington.

Angle of deflection - in directional drilling, the angle, expressed in degrees, at which a well is deflected from the vertical by a deflecting tool.

Annular blowout preventer - a large valve, usually installed above the ram preventers, which forms a seal in the annular space between the pipe and wellbore or, if no pipe is present, on the annulus.

Annular space - 1. the space surrounding a cylindrical object within a cylinder. 2. the space around a pipe suspended in a wellbore, the outer wall of which may be the wall of either the borehole or the casing; sometimes termed the annulus.

Anticline - an arched, inverted-trough configuration of folded and stratified rock layers.

B

Back off - to unscrew one threaded section of pipe from another.

Back up - to hold one section of pipe while another is being screwed into or out of it.

Bail - (noun) a cylindrical steel bar (similar to the handle or bail of a bucket only much larger) that supports the swivel and connects it to the hook. Sometimes, the two cylindrical bars that support the elevators and attach them to the hook are called bails.

Bail - (verb) to recover bottom-hole fluids, samples, or drill cuttings by lowering a cylindrical vessel, called a bailer, to the bottom of a well, filling it, and retrieving it.

Bailing line - cable attached to the bailer, passed over a sheave at the top of the derrick, and spooled on the reel.

Barrel - a measure of volume for petroleum products. One barrel (1 bbl) is the equivalent of 42 U.S. gal, or approximately 35 imperial gal, or 158.97 liters. One cubic meter (1 $m^3$) equals 6.2897 bbl.

Basket sub - a fishing accessory run above a bit or mill to recover small pieces of metal or junk in a well.

Bed - a specific layer of earth or rock in contrast to other layers of different material lying above, below, or adjacent to it.

Belt - a flexible band or cord connecting and passing about each of two or more pulleys to transmit power or impart motion.

Bit - the cutting or boring element used in drilling oil and gas wells. Most bits used in rotary drilling are roller-cone bits. The bit consists of the cutting element and circulating element. The circulating element permits the passge of drilling fluid and utilizes the hydraulic force of the fluid stream to improve drilling rates. In

**Bit** (continued) - rotary drilling several drill collars are joined to the bottom end of the drill-pipe column. The bit is attached to the end of the drill collar.

**Bit breaker** - a heavy plate which fits in the rotary table and holds the drill bit while it is being unscrewed from the drill stem.

**Bit record** - a report on each bit used in an operation listing its type, the amount of footage it has drilled, and the nature of the formation penetrated.

**Blind ram** - an integral part of a blowout preventer serving as the closing element. Its ends do not fit around the drill pipe but seal against each other and completely shut the space below.

**Block** - any assembly of pulleys on a common framework; in mechanics, one or more pulleys, or sheaves, mounted to rotate on a common axis. The crown block is an assembly of sheaves mounted on beams at the top of the derrick. The drilling line is reeved over the sheaves of the crown block alternately with the sheaves of the traveling block, which is hoisted and lowered in the derrick by the driling line. When elevators are attached to a hook on the traveling block, and when drill pipe is latched in the elevators, the pipe can be raised or lowered in the derrick or mast.

**Blooey line** - the discharge pipe from a well being drilled by air that conducts the air and drilled cuttings away from the rig.

**Blowout** - an uncontrolled flow of gas, oil, or other well fluids into the atmosphere. A blowout, or gusher, can occur when formation fluids enter the wellbore and steps are not taken to stop the entry of fluids. A kick warns of an impending blowout.

**Blowout preventer (BOP)** - equipment installed at the wellhead at surface level on land rigs and on the seafloor of floating offshore rigs to preevnt the escape of pressure either in the annular space between the casing and drill pipe or in an open hole during drilling and completion operations. (See annular blowout preventer and ram blowout preventer.)

**Boll weevil** - (slang) an experienced rig or oil-field worker, sometimes shortened to "weevil."

**Bond** - the state of one material adhering or being joined to another material (as cement to formation). (verb) to adhere or be joined to another material.

**Borehole** - the wellbore; the hole made by drilling or boring.

**Bottom-hole** - pertaining to the lowest or deepest part of a well.

**Bottom-hole pressure** - the pressure in a well measured at or near the bottom of the hole.

**Break out** - to unscrew one section from another section of pipe, especially drill pipe while it is being withdrawn from the wellbore. During this operation, the breakout tongs are used to start the unscrewing operation.

**Bring in a well** - to complete a well and put it in producing status.

**Buck up** - to tighten up a threaded connection (as two joints of drill pipe).

C

**Cable** - a rope of wire, hemp, or other strong fibers.

**Cable-tool drilling** - a drilling method in which the hole is drilled by dropping a sharply pointed bit on the bottom of the hole. The bit is attached to a cable, and the cable is picked up and dropped, picked up and dropped, over and over, as the hole is drilled.

**Cap rock** - impermeable rock overlying an oil or gas reservoir that tends to prevent migration of oil or gas out of the reservoir.

**Cased hole** - a wellbore in which casing has been run.

**Casing coupling** - a tubular section of pipe that is threaded inside and used to connect two joints of casing.

**Casinghead** - a heavy, flanged steel fitting that connects to the first string of casing and provides a housing for the slips and packing assemblies by which intermediate strings of casing are suspended and the annulus sealed off. It is also called a spool.

**Casing** - steel pipe placed in an oil or gas well as drilling progresses to prevent the wall of the hole from caving during drilling and to provide a means of extracting petroleum if the well is productive.

**Casing centralizer** - a device secured around the casing at regular intervals to center it in the hole. Casing that is centralized allows a more uniform cement sheath to form around the pipe.

**Casing shoe** - a short, heavy, hollow, cylindrical steel section with a rounded bottom, which is placed on the end of the casing string to serve as a reinforcing shoe and to aid in cutting off minor projections from the borehole wall as the casing is being lowered; also called a guide shoe.

**Casing string** - casing is manufactured in lengths of about 30 ft., each length or joint being joined to another as casing is run in a well. The entire length of the joints of casing is called the casing string.

**Catch samples** - to obtain cuttings made by the bit as formations are penetrated for study by geologists. The samples are obtained from the drilling fluid as it emerges from the wellbore. Cuttings are carefully washed until they are free of foreign matter, dried, and labeled to indicate the depth at which they were obtained.

**Cathead** - a spool-shaped attachment on a winch around which rope for hoisting and pulling is wound. The breakout cathead, a rotating spool located on the driller's side of the drawworks, is used as a power source for unscrewing drill pipe. The makeup cathead is a power source for screwing together joints of pipe.

**Catline** - a hoisting or pulling line powered by the cathead, used to lift heavy equipment on the rig.

**Caving** - collapse of the walls of the wellbore, also called sloughing.

**Cement casing** - to fill the annulus between the casing and hole with cement to support the casing and prevent fluid migration between permeable zones.

**Cement channeling** - during a cementing operation, the rising of cement between the casing and borehole wall when the slurry fails to rise uniformly throughout the annulus.

**Cementing** - the application of a liquid slurry of cement and water to various points inside or outside the casing.

**Chain drive** - a drive system using a chain and chain gears to transmit power. Power transmissions use a roller chain in which each link is made of side bars, transverse pins, and rollers on the pins. A double roller chain is made of two connected rows of links, a triple roller chain of three, and so forth.

**Choke manifold** - the arrangment of piping and special valves called chokes through which drilling mud is circulated when the blowout preventers are closed to control the pressures encountered during a kick.

Choke line - an extension of pipe from the blowout preventer assembly, used to direct well fluids from the annulus to the choke manifold.

Christmas tree - the control valves, pressure gauges, and chokes assembled at the top of a well to control the flow of oil and gas after the well has been drilled and completed.

Circulation - the movement of drilling fluid out of the mud pits, down the drill stem, up the annulus, and back to the mud pits.

Combination string - a casing string that has joints of various collapse resistance, internal yield strength, and tensile strength designed for various depths in a specific well to best withstand the conditions of that well. In deep wells, high tensile strength is required in the top casing joints to carry the load, whereas high collapse resistance and internal yield strength are needed for the bottom joints. In the middle of the casing, average qualities are usually sufficient. The most suitable combination of types and weights of pipe helps to ensure efficient production at a minimum cost.

Come out of the hole - to pull the drill stem out of the wellbore. This withdrawal is necessary to change the bit, change from a core barrel to the bit, run electric logs, prepare for a drill-stem test, run casing, and so on.

Company representative - an employee of an operating company whose job is to represent the company's interests at the drilling location.

Complete a well - to finish work on a well and put it on productive status.

Compound - one of the mechanisms used for transmitting the power developed by the rig's engines to the drawworks, pumps, rotary, and other machinery on the rig. A compound is composed of chains, sprockets, pulleys, belts, and shafts.

Conductor pipe - a short string of large-diameter casing used to keep the top of the wellbore open and to provide means of conveying the upflowing drililng fluid from the wellbore to the pit.

Contract depth - the depth of the wellbore at which the drilling contract is fulfilled.

Core - a cylindrical sample taken from a formation for geological anaylsis. Usually a conventional core barrel is substituted for the bit and procures a sample as it penetrates the formation. (verb) to obtain a formation sample for analysis.

**Core analysis** - laboratory analysis of a core sample to determine porosity, permeability, type of rock, fluid content, angle of dip, geological age, and probable productivity of the formation.

**Core barrel** - a tubular device from 25 to 60 ft. long run at the bottom of the drill pipe in place of a bit to cut a core sample.

**Core catcher** - the part of the core barrel that holds the formation sample.

**Core cutterhead** - the cutting element of the core barrel assembly.

**Crooked hole** - a wellbore that has deviated from the vertical. It usually occurs in areas where the subsurface formations are difficult to drill, such as a section of alternating hard and soft strata steeply inclined from the horizontal.

**Crown block** - an assembly of sheaves mounted on beams at the top of the derrick over which the drilling line is reeved.

**Cuttings** - fragments of rock dislodged by the bit and brought to the surface in the drilling mud. Washed and dried cuttings are analyzed by geologists to obtain information about the formations drilled.

## D

**Day tour** - (pronounced "day tower") a period of 8 to 12 daylight hours worked by a drilling crew.

**Deadline** - the drililng line from the crown-block sheave to the anchor, so called because it does not move.

**Deadline tie-down anchor** - a device located in the rig's substructure to which the deadline is secured.

**Degasser** - the equipment used to remove undesired gas from a drilling fluid.

**Derrick** - a large load-bearing structure, usually of bolted construction. In drilling, the standard derrick has four legs standing at the corners of the substructure and reaching to the crown block. The substructure is an assembly of heavy beams used to elevate the derrick and provide space to install blowout preventers, casingheads, and so forth. Because the stardard derrick must be assembled piece by piece, it has largely been replaced by the mast, which can be lowered and raised without disassembly.

Derrickman - the crew member who handles the upper end of the drill stem as it is being hoisted out of or lowered into the hole. He is also responsible for conditioning of the drilling fluid and the circulating machinery.

Development well - 1. a well drilled in proven territory to complete a desired pattern of production. 2. an exploitation well.

Deviation - the inclination of the wellbore from the vertical. The angle of deviaton, angle of drift, or drift angle is the angle in degrees that the wellbore deviates from the vertical.

Deviation survey - an operation to determine the angle from which a bit has deviated from the vertical during drilling. There are two basic deviation surveys or drift survey instruments: one reveals the angle of deviation only; the other indicates both the angle and direction of deviation.

Diamond bit - a driling bit that has a steel body surfaced with industrial diamonds. Cutting is performed by the rotation of the very hard diamonds over the rock surface.

Diesel-electric power - the power supplied to a drilling rig by diesel engines driving electric generators, used widely on all modern rigs.

Diesel engine - a high-compression, internal-combustion engine used extensively for powering drilling rigs. In a diesel engine air is drawn into the cylinders and compressed to very high pressures; ignition occurs as fuel is injected into the compressed and heated air. Combustion takes place within the cylinder above the piston, and expansion of the combustion products imparts power to the piston.

Discovery well - the first oil or gas well drilled in a new field; the well that reveals the presence of a petroleum-bearing reservoir. Subsequent wells are development wells.

Displacement fluid - in oil-well cementing, the fluid, usually drilling mud or salt water, that is pumped into the well after the cement to force the cement out of the casing and into the annulus.

Doghouse - 1. a small enclosure on the rig floor used as an office for the driller or as a storehouse for small items. 2. any small building used as an office or for storage.

Double - a length of drill pipe, casing, or tubing, consisting of two joints screwed together. Compare thribble and fourble.

**Double board** - the derrickman's working platform, or monkeyboard, when located at a height in the derrick or mast equal to two lengths of pipe joined together. (See thribble board and fourble board).

**Drawworks** - the hoisting mechanism on a drilling rig. It is essentially a large winch that spools off or takes in the drilling line and thus raises or lowers the drill stem and bit.

**Drill collar** - a heavy, thick-walled tube, usually steel, used between the drill pipe and the bit in the drill stem to put weight on the bit so that the bit can drill.

**Driller** - the employee directly in charge of a drilling rig and crew. His main duty is operation of the drilling and hoisting equipment, but he is also responsible for the downhole condition of the well, operation of downhole tools, and pipe measurements.

**Drilling contractor** - a person or company whose business is to drill oil wells.

**Drilling crew** - a driller, a derrickman, and two or more helpers who operate a drilling rig for one tour each day.

**Drilling fluid** - the circulating fluid, one function of which is to force cuttings out of the wellbore to the surface.

**Drilling line** - a wire rope used to support the drilling tools.

**Drilling rate** - the speed with which the bit drills the formation; the rate of penetration.

**Drilling rig**

**Drill pipe** - the heavy, seamless tubing used to rotate the bit and circulate the drilling fluid. Joints of pipe 30 ft. long are coupled together by means of tool joints.

**Drill stem** - the entire length of tubular pipes, composed of the kelly, drill pipe, and drill collars, that make up the drilling assembly from the surface to the bottom of the hole.

**Drill string** - the column, or string, of drill pipe, not including the drill collars or kelly. Often, however, the term is loosely applied to include both the drill pipe and drill collars.

**Drum** - a cylinder around which wire rope is wound in the drawworks.

## E

**Electric well log** - a record of certain electrical characteristics of formations traversed by the borehole, made to identify the formations, determine the nature and amount of fluids they contain, and estimate their depth. It is also called an electric log or electric survey.

**Elevators** - clamps that grip a stand, or column, of casing, tubing, or drill pipe so that the stand can be raised or lowered into the hole.

**Exploitation well** - a well drilled to permit more effective extraction of oil from a reservoir. It is sometimes called a development well.

**Exploration well** - wildcat.

## F

**Fast line** - the end of the drilling line that is affixed to the drum of the drawworks, so called because it travels with greater velocity than any other portion of the line.

**Fault** - crack in the subsurface strata. Often strata on one side of the fault line have been displaced (upward, downward, or laterally) relative to their original positions.

**Field** - a geographical area in which a number of oil or gas wells produce from a continuous reservoir; may refer to surface area only or to underground productive formations as well. In a single field, there may be several separate reservoirs at varying depths.

**Fill the hole** - to pump drilling fluid into the wellbore while the pipe is being withdrawn. Filling the hole lessens the danger of blowout or of caving of the wall of the wellbore.

**Fingerboard** - a rack that supports stands of pipe being stacked in the derrick or mast.

**Fish** - an object left in the wellbore during drilling operations that must be recovered before work can proceed. It can be anything from a piece of scrap metal to a part of the drill stem. (verb) to recover from a well any equipment left there during drilling operations, such as a lost bit or drill collar or part of the drill string.

**Fishing tool** - a tool designed to recover equipment lost in the well.

Floorman - a drilling crew member whose work station is on the derrick floor. On rotary drilling rigs, there are at least two floormen on each crew, and sometimes three or more are employed.

Fluid - a substance that flows and yields to any force tending to change its shape. Liquids and gases are fluids.

Formation - a bed or deposit composed throughout of substantially the same kinds of rock. Each different formation is given a name, frequently as a result of study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

Formation fracturing - a method of stimulating production by increasing the permeability of the producing formation. Under extremely high hydraulic pressure, a fluid (as water, oil, alcohol, dilute hydrochloric acid, liquefied petroleum gas, or foam) is pumped downward through tubing or drill pipe and forced into the perforations in the casing. The fluid enters the formation and parts or fractures it. Sand grains, aluminum pellets, glass beads, or similar materials are carried in suspension by the fluid into the fractures. These are called propping agents or proppants. When the pressure is released at the surface, the fracturing fluid returns to the well, and the fractures partially close on the proppants, leaving channels for oil to flow through them to the well. This process if often called a frac job.

Formation pressure - the pressure exerted by fluids in a formation, recorded in the hole at the level of the formation with the well shut in.

G

Gas sand - a stratum of sand or porous sandstone from which natural gas is obtained.

Gas show - the gas that appears in drilling fluid returns, indicating the presence of a gas zone.

Geologist - a scientist who procures and interprets the data pertaining to the strata of the earth's crust.

Geology - the science that relates to the study of the structure, origin, history, and development of the earth and its inhabitants as revealed in rocks, formations, and fossils.

Graveyard tour - the shift of duty on a drilling rig that starts at or about midnight.

Guide shoe - a short, heavy, cylindrical steel section, filled with concrete and rounded at the bottom, and placed at the end of the casing string. It prevents the casing from snagging on irregularities in the borehole as it is lowered. A hole in the center of the shoe allows the drilling fluid to pass up into the casing while the casing is being lowered and permits the cement to pass out during cementing operations.

## H

Hoist - 1. an arrangement of pulleys and wire rope or chain used for lifting heavy objects. 2. a winch or similar device. 3. the drawworks.

Hoisting drum - the large, flanged spool in the drawworks on which the drilling line is wound.

Hook - a large, hook-shaped device from which the elevator bails and the swivel are suspended. It is designed to carry maximum loads ranging from 100 to 650 tons and turns on bearings its supporting housing. A strong spring within the assembly cushions the weight of a stand (90 ft) of drill pipe, permitting the pipe to be made up and broken out with less damage to the tool-joint threads.

Hopper - a large funnel through which solid materials may be passed and mixed with liqiud injected through a connection at the bottom. A hopper is used to mix cement slurry, combine clay and oil or water to make a drilling fluid, and so on.

Hydraulic fracturing - the forcing into a formation of liquids under high pressure to open passages for oil and gas to flow into and through the wellbore.

Hydrocarbons - organic compounds of hydrogen and carbon, whose densities, boiling points, and freezing points increase as their molecular weights increase. Although composed only of two elements, hydrocarbons exist in a variety of compounds, because of the strong affinity of the carbon atom for other atoms and for itself. The smallest molecules of hydrocarbons are gaseous; the largest are solids.

## I

Impermeable - preventing the passage of fluid. A formation may be porous yet impermeable if there is an absence of connecting passages between the voids within it.

**Instrumentation** - a device or assembly of devices designed for one or more of the following functions: to measure operating variables (as pressure, temperature, rate of flow, speed of rotation, etc.); to indiate these phenomena with visible or audible signals; to record them; to control them within a predetermined range; and to stop operations if the control fails. Simple instrumentation might consist of an indicating pressure gauge only. In a completely automatic system, the desired range of pressure, temperature, and so on is predetermined and preset.

**Intermediate casing string** - the string of casing set in a well after the surface casing to keep the hole from caving and to seal off troublesome formations. The string is sometimes called protective casing.

## J

**Jet bit** - a drilling bit having nozzles through which drilling fluid is directed in a high-velocity stream toward the bottom of the bit cones to improve the drilling efficiency of the bit.

**Jet gun** - an assembly, including a carrier and shaped charges, that is used in jet perforating.

**Jet perforate** - to burn a hole through the casing with a shaped charge of high explosives. The loaded charges are lowered into the hole to the desired depth. Once detonated, the charges emit short, penetrating jets of high-pressure gases that cut holes in the casing and cement and some distance into the formation. Formation fluids then flow into the wellbore through the perforations.

**Junk** - metal debris lost in a hole. Junk may be a lost bit, pieces of a bit, milled pieces of pipe, wrenches, or any relatively small object that impedes drilling and must be fished out of the hole.

## K

**Kelly** - the heavy steel member, four- or six-sided, suspended from the swivel through the rotary table and connected to the topmost joint of drill pipe; the kelly turns the drill stem as the rotary table turns. It has a bored passageway that permits fluid to be circulated into the drill stem and up the annulus, or vice versa.

**Kelly bushing** - a device fitted to the rotary table through which the kelly passes and by means of which the torque of the rotary table is transmitted to the kelly and to the drill stem.

Kelly spinner - a pneumatically operated device mounted on top of the kelly which, when actuated, causes the kelly to turn or spin. It is useful when the kelly or a joint of pipe attached to it must be spun up; i.e., rotated rapidly in order to make it up.

Kick - the entry of formation fluids into the wellbore. If steps are not taken to prevent further entry of fluids after a kick is detected, a blowout may occur.

## L

Latch - attach elevators to a section of pipe to pull it out of or run it into the hole.

Lead tongs - the pipe tongs suspended in the derrick or mast and operated by a wireline connected to the breakout cathead. Also called breakout tongs.

Lease - 1. a legal document executed between a landowner, or lessor, and a company or individal as lessee that grants the right to exploit the premises for minerals or other products. 2. the area where production wells, stock tanks, separators, and other production equipment are located.

Location - the place where a well is drilled.

Log - a systematic recording of data, as from the driller's log, electrical well log, radioactivity log or mud log. Many different logs are run in wells being produced or drilled to obtain various characteristics of downhole formations.

## M

Make a connection - to attach a joint of drill pipe onto the drill stem suspended in the wellbore.

Make a trip - to hoist the drill stem out of the wellbore to perform one of a number of operations such as changing bits, taking a core, and so forth, and then to return the drill stem to the wellbore.

Make up - 1. to assemble and join parts to form a complete unit (as to make up a string of casing). 2. to screw together two threaded pieces. 3. to mix or prepare (as to make up a tank of mud). 4. to compensate for (as to make up for lost time).

Make up a joint - to screw a length of pipe into another length of pipe.

**Make hole** - to deepen the hole made by the bit; to drill ahead.

**Mast** - a portable derrick capable of being erected as a unit, as distinguished from a standard derrick, which cannot be raised to a working position as a unit.

**Master bushing** - a device that fits into the rotary table. It serves as a place for setting the skips and provides a means for engaging the kelly bushing so that the rotating motion of the rotary table can be transmitted to the kelly.

**Mill** - A downhole tool with rough, sharp, extremely hard cutting surfaces for removing metal by grinding or cutting. Mills are run on drill pipe or tubing to grind up debris in the hole, remove sections of casing for sidetracking or stuck portions of drill stem, or to ream out tight spots in the casing. They are also, called junk mills, reaming mills, and so forth, depending on what use they have. (verb) to use a mill to cut or grind metal objects that must be removed from a well.

**Monkeyboard** - the derrickman's working platform. As pipe or tubing is run into or out of the hole, the derrickman must handle the top end of the pipe, which may be as high as 90 ft. in the derrick or mast. The monkeyboard provides a small platform to raise him to the upper height to be able to handle the top of the pipe.

**Motorman** - the crew member on a rotary drilling rig responsible for the care and operation of drilling engines.

**Mousehole** - an opening through the rig floor, usually lined with pipe, into which a length of drill pipe is placed temporarily for later connection to the drill string.

**Mousehole connection** - the addition of a length of drill pipe to the active string. The length to be added is placed in the mousehole, made up to the kelly, pulled out of the mousehole, and subsequently made up into the string.

**Mud** - the liquid circulated through the wellbore during rotary drilling. In addition to its function of bringing cuttings to the surface, drilling mud cools and lubricates the bit and drill stem, protects against blowouts by holding back subsurface pressures, and deposits a mud cake on the wall of the borehole to prevent loss of fluids to the formation. Although it originally was a suspension of earth solids (especially clays) in water, the mud used in modern drilling operations is a more complex, three-phase mixture consisting of liquids, reactive solids, and inert solids. The liquid phase may be fresh water, diesel oil, or crude oil and may contain one or more conditioners.

Mud cake - the sheath of mud solids that forms on the wall of the hole when the liquid from the mud filters into the formation; also called wall cake or filter cake.

Mud circulation - the act of pumping mud downward to the bit and back up to the surface by normal circulation or reverse circulation.

Mud pump - a large reciprocating pump used to circulate the mud on a drilling rig. A typical mud pump is a piston pump whose pistons travel in replaceable liners and are driven by a crankshaft actuated by an engine or motor. Also called a slush pump.

N

Natural gas - a highly compressible, highly expansible mixture of hydrocarbons having a low specific gravity and occurring naturally in a gaseous form. Besides hydrocarbon gases, natural gas may also contain appreciable quantities of nitrogen, helium, carbon dioxide, and contaminants (as hydrogen sulfide and water vapor). Although gaseous at normal temperatures and pressures, certain of the gases comprising the mixture that is natural gas are variable in form and may be found either as gases or liquids under suitable conditions of temperature and pressure.

Nipple up - in drilling, to assemble the blowout preventer stack on the wellhead at the surface.

Normal circulation - the smooth, uninterrupted circulation of drilling fluid down the drill stem, out the bit, and up the annular space between the pipe and the hole back to the surface.

O

Oil field - the surface area overlying an oil reservoir or reservoirs. Commonly, the term includes not only the surface area but may include the wells and production equipment as well.

Oil sand - 1. a sanstone that yields oil. 2. (by extension) any reservoir that yields oil, whether or not it is sandstone.

Oil zone - formation or horizon of a well from which oil may be produced. The oil zone is usually immediately under the gas zone and on top of the water zone if all three fluids are present and segregated.

**Open hole** - any wellbore in which casing has not been set.

**Operator** - the person, or company, either proprietor or lessee, actually operating an oil well or lease.

**Overshot** - a fishing tool attached to tubing or drill pipe and lowered over the outside wall of pipe that is lost or stuck in the wellbore. A friction device in the overshot, usually either a basket or a spiral grapple, firmly grips the pipe allowing the fish to be pulled from the hole.

P

**Pay sand** - the producing formation, often one that is not even sandstone. Also called pay zone and producing zone.

**Perforate** - to pierce the casing wall and cement to provide holes through which formation fluids may enter, or to provide holes in the casing so that materials may be introduced into the annulus between the casing and the wall of the borehole. Perforating is accomplished by lowering into the well a perforating gun, or perforator, that fires electrically detonated bullets or shaped charges from the surface.

**Permeability** - 1. a measure of the ease with which fluids can flow through a porous rock. 2. the fluid conductivity of a porous medium. 3. the ability of a fluid to flow within the interconnected pore network of a porous medium.

**Petroleum** - oil or gas obtained from the rocks of the earth.

**Plug and abandon (P. & A.)** - to place cement plugs of rock, usually small and often filled with fluid (as water, gas, oil or all three).

**Porosity** - a state of voids or open spaces existing in rock.

**Positive choke** - a choke in which the orifice size must be changed to change the rate of flow through the choke.

**Pressure** - the force that a fluid (liquid or gas) exerts when it is in some way confined within a vessel, pipe, hole in the ground, and so forth, such as that exerted against the inner wall of a tank, or that exerted on the bottom of the wellbore by driling mud. Pressure is often expressed in terms of force per unit of area, as pounds per square inch (psi).

**Pressure gauge** - an instrument for measuring fluid pressures that usually registers the difference between atmospheric pressure and the pressure of the fluid being measured by indicating the effect of such pressures upon a measuring element (as a column of liquid, a Bourdon tube, a weighted piston, a diaphragm, or other pressure-sensitive device).

Primary cementing - the cementing operation that takes place immediately after the casing has been run into the hole; used to provide a protective sheath, around the casing, to segregate the producing formation, and to prevent the migration of undesirable fluids.

Prime mover - an internal-combustion engine that is the source of power for the drilling rig in oil well drilling.

Production - 1. the phase of the petroleum industry that deals with bringing the well fluids to the surface and separating them, and with storing, gauging, and otherwise preparing the product for the pipeline. 2. the amount of oil or gas produced in a given period.

Proppant - a granular substance (as sand grains, glass beads, or other material) carried in suspension by the fracturing fluid that serves to keep the fracture open when the fracturing fluid is withdrawn after a fracture treatment.

psi - pounds per square inch.

Pump - a device that increases the pressure on a fluid or raises it to a higher level. In drilling, the mud pump picks up mud from one of the mud pits, forces it out the pump discharge line, up the standpipe, down the rotary hose, kelly, and the standpipe, down the rotary hose, kelly, and drill stem, out of the bit, and back up the annulus to the mud pits.

Pump pressure - fluid pressure arising from the action of the pump.

R

Radioactivity well logging - the recording of the natural or induced radioactdive characteristics of subsurface formations by slowly pulling a special tool out of a hole drilled through the formations.

Rathole - A in the rig floor from 30 to 35 ft. deep, lined with casing that projects above the floor, into which the kelly and swivel are placed when hoisting operations are in progress.

Reeve the line - to string a wire-rope drilling line through the sheaves of traveling and crown blocks to the hositing drum.

**Reservoir** - a subsurface, porous, permeable rock body in which oil and/or gas is stored. Most reservoir rocks are limestones, dolomites, sandstones, or a combination of these. The three basic types of hydrocarbon reservoirs are oil, gas, and condensate. An oil reservoir generally contains three fluids, gas, oil and water, with oil the dominant product. In the typical oil reservoir, these fluids occur in different phases because of the variance in their gravities. Gas, the lights, occupies the upper part of the reservoir rocks; water, the lower part; and oil, the intermediate section. In addition to occurring as a cap or in solution, gas may accumulate independently of the oil; if so, the reservoir is called a gas reservoir. Associated with the gas, in most instances, are salt water and some oil. In a condensate reservoir, the hydrocarbons may exist as a gas, but, when brought to the surfaces, some of the heavier ones condense to a liquid or condensate.

**Reverse circulation** - the return of drilling fluid through the drill stem. The normal course of drilling fluid circulation is downward through the drill stem and upward through the annular space surrounding the drill stem. For special problems, normal circulation is sometimes reversed, and the fluid returns to the surface through the drill stem, or tubing, after being pumped down the annulus.

**Rig** - the derrick, drawworks, and attendant surface equipment of a drilling unit.

**Rig down** - to dismantle the drilling rig and auxiliary equipment following the completion of drilling operations; to tear down.

**Rig up** - to prepare the drilling rig for making hole; to install tools and machinery before drilling is started but after the derrick has been built for the mast raised.

**Rotary drilling** - a drilling method in which a hole is drilled by a rotating bit to which downward force is applied. The bit is fastened to and rotated by the drill stem, which also provides a passageway through which the drilling fluid is circulated. Additional joints of drill pipe are added as drilling progresses.

**Rotary hose** - the hose on a rotary drilling rig that conducts the drilling fluid from the mud pump and standpipe to the swivel and kelly; also called the mud hose or the kelly hose.

**Roughneck** - a worker on a drilling rig, subordinate to the driller; sometimes called a rotary helper, floorman, or rig crewman.

**Round trip** - to pull out and subsequently run back into the hole a string of drill pipe or tubing, also called tripping the pipe.

**Run in** - to go into the hole with tubing, drill pipe, and so forth.

## S

**Samples** - 1. the well cuttings obtained at designated footage intervals during drilling. From an examination of these cuttings, the geologist determines the type of rock and formations being drilled and estimates oil and gas content. 2. small quantities of well fluids obtained for analysis.

**Sand** - 1. an abrasive material composed of small quartz grains formed from the disintegration of preexisting rocks. Sand consists of particles less than 2 mm and greater than 1/16 mm in diameter. 2. sandstone.

**Scratcher** - a device fastened to the outside of casing that removes the mud cake from the wall of the hole to condition the hole for cementing. By rotating or moving the casing string up and down as it is being run into the hole, the scratcher, formed of stiff wire, removes the cake so that the cement can bond solidly to the formation.

**Secondary cementing** - any cementing operation after the primary-cementing operation. Secondary cementing includes a plug-back job, in which a plug of cement is positioned at a specific point in the well and allowed to set. Wells are plugged to shut off bottom water, or to reduce the depth of the well for other reasons.

**Seismograph** - a device that detects vibrations in the earth, used in prospecting for probable oilbearing structures. Vibrations are created by discharging explosives in shallow boreholes or by striking the surface with a heavy blow. The type and velocity of the vibrations (as recorded by the seismograph) indicate the general characteristics of the section of earth through which the vibrations pass.

**Set casing** - to run and cement casing at a certain depth in the wellbore; to set pipe.

**Shale** - a fine-grained sedimentary rock composed of consolidated silt, clay, or mud. Shale is the most frequently occurring sedimentary rock.

**Shaped charge** - a relatively small container of high explosive that is loaded into a perforating gun. Upon detonation, the charge releases a small, high-velocity stream of particles (a jet) that penetrates the casing and cement.

**Sheave** - (pronounced "shiv") a grooved pulley.

Show - the appearance of oil or gas in cuttings, samples, cores, or drilling mud.

Shut down - to stop work temporarily or to stop a machine or operation.

Sidewall coring - a coring technique especially useful in soft rock areas in which core samples are obtained from a zone that has already been drilled. A hollow bullet is fired into the formation wall to capture the core and then retrieved on a flexible steel cable. Core samples of this type usually range from 3/4 to 1 in. in length.

Single - a joint of drill pipe. Compare double, thribble, and fourble.

Slips - wedge-shaped pieces of metal with teeth or other gripping elements that are used to prevent pipe from slipping down into the hole or to hold pipe in place. Rotary slips fit around to hold pipe and wedge against the master bushing to support the pipe. Power slips are pneumatically or hydraulically actuated devices that allow the crew to dispense with the manual handling of slips when making a connection.

Slurry - a thin, watery mixture of cement and water that is pumped into a well to harden; after hardening, it supports the casing and provides a seal in the wellbore to prevent migration of underground fluids.

Spear - a fishing tool used to retrieve pipe lost in a well. The spear is lowered down the hole and into the lost pipe, and, when weight, torque, or both are applied to the string to which the spear is attached, slips in the spear expand and tightly grip the inside wall of the lost pipe. Then the string spear, and lost pipe are pulled to the surface.

Spinning cathead - a spooling attachment on the makeup cathead to permit use of a spinning chain to spin up or make up drill pipe.

Spinning chain - a Y-shaped chain used to spin up (tighten) one joint of drill pipe into another. In use, one end of the chain is attached to the tongs, another end to the spinning cathead, and the third end is free. The free end is wrapped around the tool joint and the cathead pulls the chain off the joint, causing the joint to spin (turn) rapidly and tighten up. After the chain is pulled off the joint, the tongs are secured in the same spot, and continued pull on the chain (and thus on the tongs) by the cathead makes the joint up to final tightness.

Spud - to begin drilling; to start the hole.

**Squeeze cementing** - the forcing of cement slurry by pressure to specified points in a well to cause seals at the points of squeeze. It is a secondary-cementing methods, used to isolate a producing formation, seal off water, repair casing leaks, and so forth.

**Stab** - to guide the end of a pipe into a tool joint when making up a connection.

**Stabbing board** - a temporary platform erected in the derrick or mast some 20 to 40 ft. above the derrick floor. The derrickman or another crew member works on the board while casing is being run in a well. The board may be wooden or fabricated of steel girders floored with antiskid material and powered electrically to raise or lower it to the desired level. A stabbing board serves the same purpose as a monkeyborad but is temporary instead of permanent.

**Stake a well** - to locate precisely on the surface of the ground the point at which a well is to be drilled. After exploration techniques have revealed the possiblity of the existence of a subsurface hydrocarbon-bearing formation, a certified and registered land surveyor drives a stake into the ground to mark the spot where the well is to be drilled.

**Standpipe** - a vertical pipe rising along the side of the derrick or mast which joins the mud pump to the rotary hose and through which mud is pumped.

**Stands** - the connected joints of pipe racked in the derrick or mast when making a trip.

**Stimulation** - any process undertaken to enlarge old channels or create new ones in the producing formation of a well (e.g., acidizing or formation fracturing).

**Stratification** - the natural layering or lamination characteristic of sediments and sedimentary rocks.

**Stratigraphic trap** - a petroleum trap that occurs when the top of the reservoir bed is terminated by other beds or by a change of porosity or permeability within the reservoir itself.

**String** - the entire length of casing, tubing, or drill pipe run into a hole; the casing string. (Compare drill string and drill stem).

**String up** - to thread the drilling line through the sheaves of the crown block and traveling block. One end of the line is secured to the hoisting drum and the other to the derrick substructure.

Structural trap - a petroleum trap that is formed because of deformation (as folding or faulting) of the rock layer that contains petroleum.

Stuck pipe - the drill pipe, drill collars, casing, or tubing that has inadvertently become lodged immovably in the hole. It may occur when drilling is in progress, when casing is being run in the hole, or when the drill pipe is being hoisted.

Sub - a short, threaded piece of pipe used to adapt parts of the drilling string which cannot otherwise be screwed together because of difference in thread size or design. A sub may also perform a special function. Lifting subs are used with drill collars to provide a shoulder to fit the drill-pipe elevators. A kelly saver sub is placed between the drill pipe and kelly and drill-pipe thread. A bent sub is used when drilling a directional hole.

Substructure - the foundation on which the derrick or mast and drawworks sit, containing space for storage and well-control equipment.

Surface pipe - the first string of casing (after the conductor pipe) that is set in a well, varying in length from a few hundred feet to several thousand. Some states require a minimum length to protect freshwater sands. Compare conductor pipe.

Swivel - a rotary tool that is hung from the rotary hook and traveling block to suspend and permit free rotation of the drill stem. It also provides a connection for the rotary hose and a passageway for the flow of drilling fluid into the drill stem.

## T

Thread protector - a device that is screwed onto pipe threads to protect the threads from damage when the pipe is not in use.

Thribble - a stand of pipe made up of three joints and handled as a unit.

Throw the chain - to flip the spinning chain up from a tool-joint box so that the chain wraps around the tool-joint pin after it is stabbed into the box. The stand or joint of drill pipe is turned or spun by a pull on the spinning chain from the cathead on the drawworks.

Tight formation - a petroleum- or water-bearing formation of relatively low porosity and permeability.

**Tight hole** - a well about which information is restricted and passed only to those authorized for security or competitive reasons.

**Tongs** - the large wrenches that are latched onto drill pipe or drill collars in order to make up (tighten) or break out (loosen) a joint of drill pipe or drill collars. Power tongs are pneumatically or hydraulically operated tools that serve to spin the pipe up tight and in some cases, to apply the final makeup torque.

**Tool joint** - a heavy coupling element for drill pipe, made of special alloy steel. Tool joints have coarse, tapered threads and seating shoulders designed to sustain the weight of the drill stem, withstand the strain of frequent coupling and uncoupling, and provide a leakproof seal. The male section of the jonit, the pin, is attached to one end of a length of drill pipe, and the female section, or the box, is attached to the other end. The tool joint may be welded to the end of the pipe, or screwed on or both. A hard metal facing is often applied in a band around the outside of the tool joint to enable it to resist abrasion from the walls of the borehole.

**Tool pusher** - an employee of a drilling contractor who is in charge of the entire drilling crew and the drilling rig.

**Torque** - the turning force that is applied to a shaft or other rotary mechanism to cause it to rotate or tend to do so. Torque is measured in foot-pounds, joules, meter-kilograms, and so forth.

**Torque converter** - a connecting device between a prime mover and the machine actuated by it. The elements that pump the fluid in the torque converter automatically increase the output torque of the engine to which the torque is applied, with an increase of load on the output shaft. Torque converters are used extensively on mechanical drilling rigs that have a compound.

**Total depth (TD)** - the maximum depth reached in a well.

**Tour** - (pronounced "tower") a shift worked by a drilling crew or other oil-field workers. Sometimes 12-hour tours are employed, especially on offshore drilling rigs. The most common divisions of tours are daylight, evening, and graveyard.

**Trap** - layers of buried rock strata that are arranged so that petroleum accumulates in them.

**Traveling block** - an arrangment of pulleys, or sheaves, through which drilling cable is reeved, and which moves up and down in the derrick or mast.

## V

**Valve** - a device used to control the rate of flow in a line, to open or shut off a line completely.

## W

**Waiting on cement (WOC)** - pertaining to or during the time when drilling or copmletion operations are suspended so that the cement in a well can harden sufficiently.

**Wall cake** - the compacted solid or semisolid material remaining on a filter after pressure filtration of mud with a standard filter press. Its thickness is measured in thirty-seconds of an inch. Wall cake may also refer to a layer of concentrated solids from drilling mud, which forms on the walls of the borehole opposite permeable formations, sometimes called mud cake.

**Weight indicator** - an instrument near the driller's position on a drilling rig. It shows both the weight of the drill stem that is hanging from the hook (hook load) and the weight that is placed on the bit by the drill collars (weight on bit).

**Wellbore** - a borehole; the hole drilled by the bit. A wellbore may have casing in it or it may be open (i.e., uncased); or a portion of it may be cased and a portion of it may be open.

**Well completion** - the activities and methods necessary to prepare a well for the production of oil and gas; the method by which a flow line for hydrocarbons is established between the reservoir and the surface.

**Wellhead** - the equipment installed at the surface of the wellbore. A wellhead includes such equipment as the casinghead, tubing head, and Christmas tree. (adj.) pertaining to the wellhead (as wellhead pressure).

**Well logging** - the recording of information about subsurface geological formations. Logging methods include records kept by the driller, mud and cuttings analyses, core analysis, drill stem tests, and electric and radioactivity procedures.

**Well stimulation** - any of several operations used to increase the production of a well.

**Wildcat** - a well drilled in an area where no oil or gas production exists. With present-day exploration methods and equipment, about one wildcat out of every six proves to be productive although not necessarily profitable.

**Wire rope** - a rope composed of steel wires twisted into strands that are in turn twisted around a central core of hemp or other fiber, to create a rope of great strength and considerable flexibility. Wire rope is used as drilling line (in rotary and cable-tool rigs), coring line, servicing line, which line, and so on.